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SOVIET NOISE-CONTROL RESEARCH

(Selected Translations)

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SOVIET NOISE-CONTROL RESEARCH

[Following are the translations of selected articles on noise-control research in the USSR from Gigiyena i Sanitariya (Hygiene and Sanitation), No 9, Moscow, September 1960, pages 15-20, 21-26, 26-31, 32-35, 36-41, 50-53, 60-65, 70-73, 73-78, 79-81, 82-88, 94-98, 99-102, 103-106, 106-110, 114, 115, 115-116, and 116 respecrively.]

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COORDINATION OF RESEARCH IN THE FIELD OF NOISE CONTROL

By S. I. Murovannaya, Candidate of Medical Science,
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Coordination of scientific work based on reciprocal information regarding the research in progress is of primary importance for the development of science in any field of knowledge. It is particularly important to such a many-sided and complex problem as noise control, which still has not been sufficiently developed. In developing this problem, a collaboration and friendly cooperation of specialists in various fields are necessary; Public health and clinical physicians, physiologists, acoustics physicists, civil engineers, machine designers, architects and others.

The All-Union Conference on the Hygienic Problem of Noise Control organized by the Ministry of Public Health, USSR, November 26-29, 1957, was, to a certain extent, a turning point in attracting the attention of hygienists and practicing public health physicians to these important problems. The resolution of this Conference, along with practical tasks, mapped a number of important theoretical goals in the scientific development of this problem.

In accordance with the decisions of the Conference, a permanent Committee for Noise Control was created under the Main State Public Health Inspection of the USSR, which started operating in the second half of 1958. One of the immediate tasks of the Committee for Noise Control (according to its work regulations) was to determine the basic trends of researches on the problems of noises, as well as to coordinate the work in this field which is being conducted by the public health and other scientific organizations. The urgency of this problem was especially evident because in the last 2 decades the hygienists did but very little research on noise. It must also be kept in mind that numerous researches on the hygienic study of industrial noise which were conducted during the pre-war period were concerned almost exclusively with the influence of noise on the hearing organ, while the problems of the influence of

noise on the nervous system remained unstudied. Meanwhile, the studies (by T. A. Orlov, K. Shreder and others), conducted during the recent years, have shown that changes in the dynamics of the higher nervous activity, pathological shifts in the condition of cardiovascular system resulting from a prolonged action of noise develop much earlier than the appearance of changes in the hearing acuity. Consequently, the study of the influence of industrial noise on the state of the central nervous system and the organism as a whole should represent the most important aspect in the study of this problem.

It would be absolutely wrong to ignore the significance of former studies in this field which not only permitted to establish the nature of pathological changes developing in the auditory analyser of those working under the conditions of the influence of noise, but also to substantiate the Provisional Public Health Standards for the Abatement of Noise in Industry.

From the hygienic point of view much less attention has been given to the study of street noises, particularly the problems of their influences on the sanitary conditions of the life and the health of the population. Almost completely unstudied until very recently were the problems of the influence of noises of relatively low intensity on the organism which affect human being u n d e r everyday living conditions in their residences. Under these circumstances, the science of hygiene did not have at its disposal the necessary data in order to establish hygienic standards - the maximum allowable levels of city noise and of noise in residential buildings. At the same time the absence of hygienic standardization in this respect considerably hinders the development and the carrying out of practical measures of technical and administrative nature for the lessening of the city noises and for the improvement of the soundproofing in housing construction.

The Committee for Noise Control recognized that the basic trend in studying this problem should be the clarification of the influence of noise on the organism as a whole (the state of the central nervous system, of the higher nervous activity, of the autonomic nervous system of the regulation of the functions of cardiovascular systems etc.) with a simultaneous study of the state of the auditory analyser. For a hygienic substantiation of permissible levels of noise in residential buildings, it is necessary to conduct research work on the effect of noises of low intensity on the human organism, which in turn requires the development of appropriate methods and the organization of work in laboratories and under natural conditions.

For a hygienic standardization of street noises, it is necessary, along with the study of noise condition in cities, to set up mass and detailed studies of a psychohygienic nature to show the reaction of the population to city noises both by means of questionaires and by a special physiological and hygienic research. In studying industrial noise, the main attention should be concentrated on showing the influence of noises of various nature (fixed, interrupted, pulsed and others). These materials should serve as a basis for defining more accurately the Provisional Public Health Standards for the Abatement of Noise in Industry. A simultaneous study of the parameters of noise from individual sources (lathes and aggregates) is an important problem which will permit to substantiate the maximum permissible levels of noise in new industrial equipment.

In all instances, it is of paramount importance to study the influence of noise on the condition of cardiovascular system, which is one of the highest in the morbidity among the population. Such a study requires a concrete participation of physiologists and clinicians, who, until recently, did not concern themselves with this problem. For this purpose, the Committee has established contacts with the appropriate problem committees of the presidium of the Academy of Medical Sciences, USSR (Problem Committee No. 1 - "physiology and pathology of higher nervous activity"; Problem Committee No. 2 - "basic physiological functions, their nervous and humoral regulation"; Problem Committee No. 44 - "hypertonic disease, atherosclerosis and coronary insufficiency" and others) and requested them to include in the research plans which are coordinated by these Committees the problems of the influence of noise on the regulation of the function of the cardiovascular system and the role of noise stimulus in the activity of the nervous system. This resulted in the inclusion of the above problems into the long-term plans of a number of clinical institutes and physiology departments, which may be considered as the beginning of their participation in the solution of this important hygienic problem.

The Committee has also established contacts with individual technical research institutes studying the problems of the control of noise of various type. Representatives of scientific and designing technical institutes were consistently invited to the meetings of the Committee at which communications and reports on their work were heard, which has played an important role in establishing contact with these institutes and facilitated the coordination of research.

As a result of the conducted work, information was

obtained regarding researches completed in 1959 and those planned for 1960 at 49 organizations which include 28 medical organizations and 21 technical organizations.

The greatest portion of medical organizations engaged in the study of noise problem are, as it should be expected, institutes of hygiene of work and occupational diseases (13 topics) and hygienic institutes and research laboratories (14 topics). Among the latter we should specifically mention the Moscow Research Institute for Sanitation and Hygiene Imeni F. F. Erisman of the Public Health Ministry RSFSR which established a special laboratory and is conducting research in the field of noises of various types (industrial, city, in residences). Of the institutes for labor protection of the VTsSPS (All-Union Central Council of Trade Unions), only the Leningrad Institute for Labor Protection (LIOT) alone has been successfully working in this field for a number of years. It prepared a draft of the Provisional Standards for the Abatement of Noise in Industry which were approved by the Main State Public Health Inspection of the USSR in 1956. Taking into consideration the wide occurrence and a high level of noise in various branches of industry, the development of new types of industry and the impending modernization of industrial equipment, it is also necessary to include the problems of silencing noises into the long-term plans of subjects of other institutes for labor protection of the VTsSPS. It should be noted with satisfaction that research on noise control has been included in the long-term plan of the Academy of Communal Economy Imeni K. D. Pamfilov. This scientific institution should play an important role in the development of problems of reducing city noises (development of designs of new noiseless means of city transportation, noiseless street coverings, etc.)

In 1959-60 a total of 91 topics are under study, which include 54 topics at the medical organizations and 37 topics in the technical organizations. The distribution of topics according to the nature of problems presented in a table is of utmost interest.

As it is seen from the quoted data, an important place in the topics of medical organizations come to be occupied by the problems of the influence of noise on the cardiovascular system and some other functions and systems of the organism (16 out of 54 topics), which should be evaluated as a positive result of active planning. Let us mention some of these topics. Thus, the Institute of Therapy, AMS USSR, has planned a topic "The significance of Noise in the Development of Hypertonia" which was started in 1959 and will be completed in 1961. The Department of Normal Physiology of the Gor'kiy Medical Institute has planned for 1959-1960 the topic "Effect of Noise on the Regulation of the Functions

Distribution of Topics by Nature of Problems under Study.

Problem under study	Number of Developed Topics — Institutions: Medical type	Technical Type	Total
Effect of noise on cardiovascular system . .	8	-	8
Effect of noise on some other functions and systems of the organism including sound analyser.	8 (2)	-	8
Industrial noise and its effect on workers(including a combined action of noise and vibration)..	26 (6)	2	28
Condition of noise in cities and measured for noise abatement of noise (including noise control in auto-transport)	7	9 (3)	16
Noise in residential buildings, including: a) Hygienic substantiation of permissible levels of noise.	5 (2)	-	5
b) Improvement of soundproofing housing const.	-	6	6
c) Improvement of soundproofing and vibroproofing of the engineering equipment in residential buildings	-	3	3
Noise control in diesels . .	-	5	5
Noise control in aerodynamic installations	-	6	6
Measuring of noise	-	6	6
TOTAL	54	37	91

of the Cardiovascular System".

The Department of Pathological Physiology of the Vinnitsa Medical Institute has planned the topic "Central Nervous Mechanisms of Regulation of the Cardiovascular System under the Effect of Noise on the Organism" (experimental studies on dogs in the case of different functional states of the higher sections of the central nervous system as well as in the case of experimental hypertonia). It has been planned further in cooperation with the Department of Hygiene to conduct observations on humans under industrial conditions and it is intended to compare the peculiarities of the reactions of the cardiovascular system with the research data on the electrical activity of the brain.

The topic "Effect of Noise on the Cardiovascular Component of the Interoceptive Reflexes" has been planned for 1959-60 by the Department of Normal Physiology of the Chita Medical Institute. In a series of chronic experiments on 20 dogs (operated by an original method) a study will be made on the effect of overtones and dissonances of various frequency and strength on the formation of the quality of synocarotid reflexes caused by the stimulation of the carotid sinus dosed according to strength. Then, against the background of the changes in the intrasinus pressure, studies will be made of the dynamics of the electrocardiogram, changes in the filling of the internal organs with blood and fluctuations of the temperature of cutaneous coverings, muscles, and internal organs.

Of the researches conducted in the above mention direction we may mention the topic of the Ukrainian Institute of the Hygiene of Work and Occupational Diseases: "Noise in Testing Diesel Engines and Its Unfavorable Effect on Certain Functions of the Organisms".

For this topic, studies in the changes of the arterial pressure of workers under industrial conditions, and in visual, vestibular, motor and sensory chronaxy have been planned along with audiometric studies of the adaptation and fatigue of the auditory analyser.

Very interesting in this respect is a work of the Institute of Hygiene of Work and Occupational Diseases, AMN SSSR, "Influence of Intensive Noise on the Functional State of the Nervous System".

It is obvious that it is impossible to present in a single article all of the topics on the problems which interest us. We should note the work of the Department of Hygiene of Work of the Leningrad Institute of Advanced Training for Doctors who undertook to study the aftereffects of a prolonged action of noise on workers in respect to its influence on general morbidity.

As a positive feature of the topics of 1960 on the study of industrial noises, we should mention the inclusion of topics on the combined action of noise and vibration (Moscow Research Institute of Sanitation and Hygiene Imeni F. F. Erisman of the Public Health Ministry, RSFSR, Department of Hygiene of Work with a clinic for occupational diseases of the Leningrad Medical Institute of Sanitation and Hygiene and others). On the whole, the problems of industrial noise are occupying the first place in the total number of topics under study (see table) and are being studied chiefly by institutes and departments of hygiene. The absence of research on industrial noise control in the departmental institutes of technical type should be considered a serious deficiency. A joint work of hygienists with research engineers in a number of technical institutes is necessary and will substantially influence the application of such research to practical use.

Second place is occupied by the problems of noise condition in the cities. They are being studied both by the institutes of hygiene and the departments of general and communal hygiene in medical institutes, as well as the institutes of the Academy of Construction and Architecture, USSR, and by other scientific technical institutions.

The research projects conducted at the Order of the Red Banner Automobile and Automobile Engine Central Research Institute (NAMI) are very urgent. In 1957 a special laboratory for noise silencing was created in this Institute. The Institute is developing mufflers for the new models of engines and automobiles planned to be put on the market within the next 2-3 years. In 1959 work was completed on improving mufflers for the engine YaAZ-204 which is installed in powerful trucks producing deafening noise and causing a great number of complaints from the population. Appropriate laboratories should be established in automobile and automobile engine plants. It is necessary to develop and introduce a single method for the study of noise (and vibration) of engines, particularly in connection with the preparation of a draft of the Provisional Standards for a Permissible Amount of Noise Created by Motor Transport.

A positive point of many research projects on studying city noises is (along with the measurement of noise levels) the questioning of the population along noisy highways (Moscow, Leningrad, Lvov, Sverdlovsk, Tashkent, and other cities). In particular, the Department of Communal Hygiene of the Leningrad Medical Institute of Sanitation and Hygiene has planned for 1960-1961 a big research project on the effect of the urban transport noises upon the health of the population which will include the interviewing of 8000-10,000

persons.

We should mention the serious difficulties with which such research is confronted due to the fact that the hygienic scientific institutions do not have modern measuring instruments at their disposal. Therefore, it is extremely advisable that such research projects be conducted jointly with the institutes of technical type which have specialized laboratories. As a positive example of such joint research of many years, we can give the collaboration of the Moscow Research Institute of Hygiene and Sanitation Imeni F. F. Erisman of Public Health Ministry RSFSR, and the Institute of Architectural Physics and Safety Constructions of the Academy of Construction Architecture USSR. The successful research of the above mentioned institute on residential noises permitted to develop a draft of the Provisional Sanitation Standards of Permissible Amount of Noise in Residential Buildings, which was approved by a scientific and practical conference summoned by the Committee on Noise Control of the Chief State Sanitary Inspection of the USSR on October 13-15, 1959. Research projects on the noise control of diesels are important. Unfortunately in this field coordination has not been achieved between the work of the hygienic and technical institutes. One of the tasks of the Committee of Noise Control for 1960 is to conduct a scientific and practical coordination conference on these problems.

Little work is still done on the methods of noise measurement and developing of new precision and portable models of acoustic measuring instruments. In the meantime their absence is hindering the development of research which is important for practical purposes and the practical work on noise control in workshops, on the streets and in residential buildings.

The Leningrad Institute for Labor Protection, VTsSPS, began, in 1959, a research on the topic of "Development of a Portable Instrument for the Control of the Observation of Standards for Noise Abatement in Industry".

It would be very desirable to speed up this work as much as possible and to have the experimental models approved for serial production. The development of instruments with the increase of the range of measured frequencies toward the upper limit, and instruments for the measurement of ultrasonic vibrations is important. The latter should be considered particularly important if we take into account the ever-increasing application of ultrasonic units in industry. The problems of ultrasound research are already reflected in the long-range topical plans of a number of scientific hygienic institutions. They are being developed in the Institute of Hygiene of Work and Occupational Diseases,

AMS, USSR, in the Department of Hygiene of Work with the Clinic of Occupational Diseases of the Leningrad Medical Institute for Sanitation and Hygiene, in the Ukrainian Institute of Hygiene of Work and Occupational Diseases, in the Moscow Research Institute for Sanitation and Hygiene Imeni F. F. Erisman of the Public Health Ministry, RSFSR.

Here it is necessary, as much as in the research on noise, to coordinate work with physiologists and acoustics specialists. First of all, communication should be extablished with the Acoustics Institute of the Academy of Sciences USSR.

Summing up the above, we may say that a big and complex job is still to be done in coordinating research on the problems of noises. It has to be of a systematic and planned nature. It is necessary to find the most effective organizational forms for conducting it (coordination conferences on narrow topics, broadening of joint research, coordination of working programs and plans for the topics of hygienic and technical institutes, etc.). All this will permit to make the work in the field of coordinating research on noise control more effective and will help to solve successfully this important hygienic problem.

Received January 28, 1960.

PHYSIOLOGICAL BASES FOR DETERMINING INDUSTRIAL NOISE STANDARDS

By A. A. Arkad'yevskiy, Candidate of Medical Sciences, Moscow Research Institute for Sanitation and Hygiene Imeni F. F. Erisman of the Ministry of Public Health, RSFSR.

Automation and modernization of industrial equipment without noise abatement causes not only an increase in the intensity but also a change in the spectral composition in noise, often toward the most dangerous high frequencies.

From published sources (Ya. S. Temkin, 1931; Swabach and Polnow, 1884; P. M. Obukhovskii and D. V. Khovanskii, 1932; P. G. Lepnev, 1934; G. S. Trambitskiy, 1925; A. A. Arkad'yevskii, 1959, and others) we know of impairment of vision under the influence of industrial noise which was expressed by a steady increase of the thresholds of audibility in the case of workers at very noisy workshops dependent on the intensity, the spectrum, and the duration of the stimulant. These materials are very important for explaining the physiological mechanism of sound perception and for the development of sanitation and preventive measures. However, such materials could not substantiate permissible levels of noise intensity in industry.

Evidently, the physiological basis for determining standards should be sought in the results of the effect of noise on the organism of those working under the conditions of its moderate intensity.

The data from the published sources on this subject are insufficient for a physiological substantiation of standards.

Research on the effect of moderate-intensity noise was done by G. L. Navyazhskiy (1948), who found changes in the auditory function at the noise level of 90-100 db. and the spectrum from 1000 to 5000 cps, but to a lesser degree than at the noise level above 100 db. On this basis the author considers the intensity limit of noise to be 70-90 db. V. G. Yermolayev (1941), while studying the effect of tones on the hearing, established that sounds of the intensity level within the limits of 80 db and at the frequency of up to 1024 cps do not cause an expressed hearing fatigue,

and D. I. Bakhrakh and B. Ya. Sheyvekhman (1949) found an impairment of hearing in workers of machine industry at the same frequency and level of noise intensity.

Researches conducted during recent years are interesting (Ye. Ts. Andreyeva-Galanina, 1957; A. P. Bruzhes and A. A. Arkadyevskiy, 1956; A. M. Volkov, 1956; M. P. Mogilnitskiy, 1936; Ye. G. Zarkhi, 1939; V. A. Uglov, 1935). These studies have established the effect of noise on many functions of the organism, on the electrical activity of the cerebral cortex, on the bioelectric phenomena of the heart, on the voluntomotory function, on the intracranial and intralabyrinth pressure, on the breathing and the pulse frequency, on the secretory function of the stomach and on the gaseous interchange. Not less interesting in this respect are the researches of foreign scholars: Smith and Laird, 1930; Coribell, 1948; Weston and Adams, 1935; Ruffer, 1932, who discovered the effect of the noise factor on the peristalsis of the stomach and the size of the spleen and kidneys. They also have pointed out that a lower labor productivity and increase of spoilage depend on the noise.

From a survey of these data it is possible to make a very general conclusion that at sufficient intensity the effect of noise apparently shows on all functions of the organism. This was not and could not be taken into account when determining standards of noise in industry (I. I. Slavin, 1956) first of all because of a discrepancy of published data and an incomplete characteristic of the factor. On the basis of the above, the aim of this paper to study the effect of industrial low frequency noise of a moderate intensity, not only on the hearing but also on other functions of the organism should be considered justified.

Observations were conducted in an acoustic chamber on people with normal hearing and general health. A study was made of the effect of noise of 3 variants of intensity: 80, 90, and 100 db on the auditory sensitivity and other functions of the organism by means of autiometry, by measuring the latent period in the visuo-motor reaction, by means of electrocardiography and by taking arterial blood pressure. Low-frequency noise was first recorded on film in industry and then was transmitted into the chamber by means of a magnetic sound recorder. A frequency-response curve of this noise as given in Illustration 1.

Illustration 1 shows that the bulk of the sound energy is concentrated within the limits of 50 to 600 cps with its highest level at the frequency of 200 cps. Taking the latter into account, as well as the steepness of the incline, which equals to 5 db at the octave following this level, such noise belongs to the low-frequency noises of the 1st class.

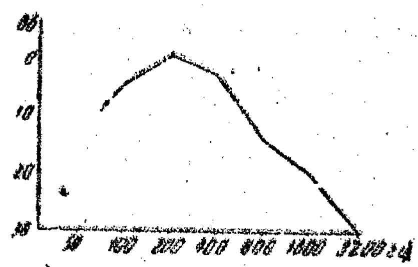

Illustration 1. Frequencies response curve of industrial noise recorded on film.

The thresholds of audibility of 4 persons under observation aged between 18 and 23 were measured with a tone generator before the noise was introduced, immediately after the stopping of noise, and during 30 minutes of aftereffect. The signals entered the ear of the observed person through a telephone of electrodynamic type with the frequency of 200, 500, 1000 and 4000 cps. More than 80 observations were conducted in this manner (about 4000 measurements of auditory sensitivity). The duration of the noise action was 1 hour.

It should be mentioned that the reaction of the auditory organ to the noise stimulation in most instances was directed unilaterally. Illustration 2 shows an averaged shift of the thresholds of audibility by the persons observed.

These data clearly reveal the tendency of the state of auditory sensitivity for each variant for noise intensity.

It can be seen that the level of the thresholds of audibility (after the action of noise) depends on the intensity of the stimulant. Thus, at all frequencies, the sound signal having the level of 80 db shows in the increase of the thresholds during the first minute of study by 3-4 db. The noise of 90 db increases the threshold of audibility by 7-10 db, and the highest shift of the threshold was found after the stopping of the noise having the intensity level of 100 db. This shift equalled to 15-18 db.

The same regularities are evident in the picture of the restoration activity of the auditory analyser. Thus, for a complete restoration of the initial thresholds after the action of the noise of 80 db intensity, 1 to 2 minutes are required, and for the noise of 90 db level, 3 to 5 minutes are required. A considerable retardation of restoration is observed after the action of the noise of 100 db

intensity, when the original value is attained only in 13-28 minutes. This time is several times greater than in the preceding observations.

The revealed dependence of the shift level of threshold sensitivity of hearing upon the intensity of the noise stimulant also shows in the audiograms of each observed person. One of them is shown in Illustration 3. There is a basis to consider that the amount of shift of the thresholds of audibility toward an increase and the retardation of the restoration process after the action of the low-frequency noise of 100 db intensity signals the danger of the fixation of the shift and the development of the phenomena of hearing difficulty. On this basis a noise of such intensity cannot be considered as permissible in industry.

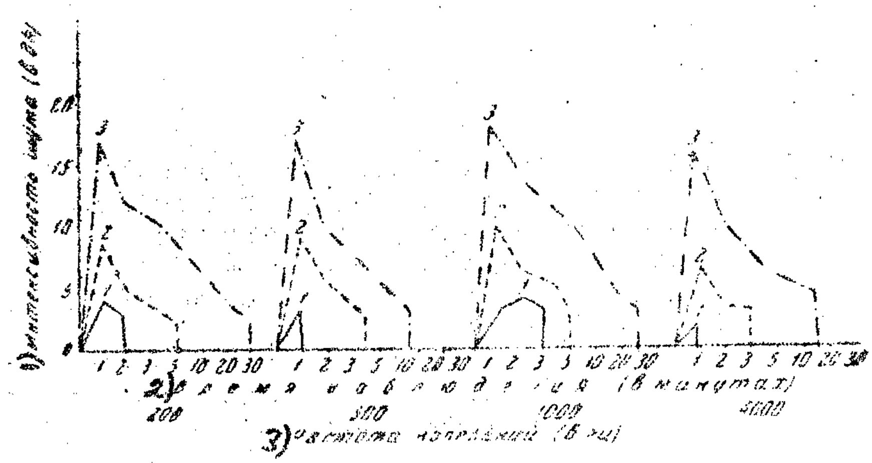

Illustration 2. Shift of threshold of audibility after the action of the low-frequency noise of 80, 90, 100 db intensity (according to averaged data for 4 observed persons). 1 - Noise of 80 db; 2 - Noise of 90 db; 3 - noise of 100 db.
Legend: 1) Intensity of noise (in decibels);
2) Time of observation (in minutes);
3) Frequency of vibrations (in cps).

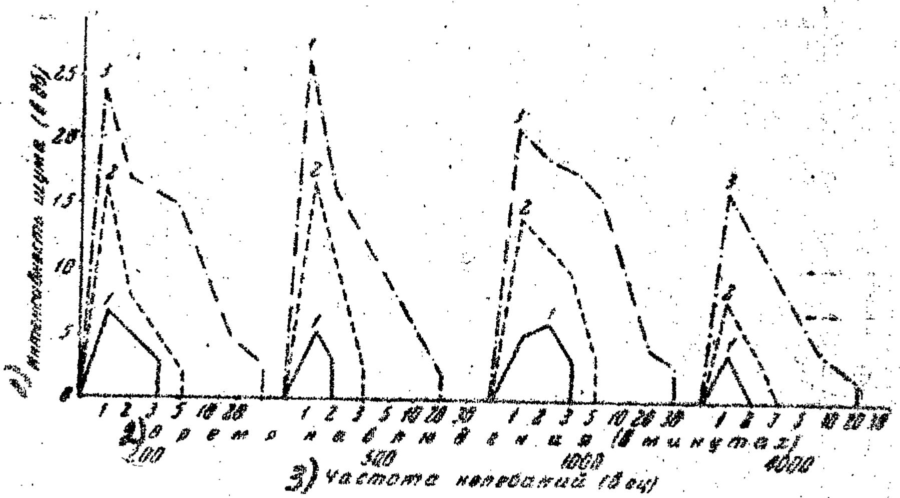

Illustration 3. Shift of the thresholds of audibility after the action of low-frequency noise of 80, 90, 100 db intensity (according to the averaged data for the observed person (K)
1 - Noise of 80 db; 2 - Noise of 90 db; 3 - Noise of 100 db.
Legend: 1) Intensity of noise (in decibels);
2) Time of observation (in minutes);
3) Frequency of vibrations (in cps).

The latent period of a simple motor response to light was measured by means of reflexometer of our own construction consisting of non-inertia electric stopwatch and a device for a simultaneous starting of the apparatus and flashing of the signal light. The person under observation responded to the light stimulation with a quick pressing of the tumbler switch of the apparatus with his hand.

Thirty-five observations were conducted on the same 4 persons. In each observation 24 answers were obtained to the same number of light signals, which amounts to about 800 measurements.

Differentiation of the data according to the intensities of the stimulant revealed the dependence of the state of visuo-motor reaction on the degree of the noise action. Thus, after the action of the noise of 80 db intensity, the number of instances of the acceleration of the reaction was equal to

one-half of the studied cases. The ratio between the retardation and the acceleration of the reaction after the noise of 90 db level changes toward an increase in the number of cases with a lengthening of the latent period and constitutes 8 out of 13. The number of such cases increases obviously after the action of the noise of 100 db intensity and reaches 12 out of 14. In remaining cases the time of the latent period of the reaction reduced, or did not change.

The deflection of this time after the noise of 80 db level fluctuated within the limits of permissible error in measurements (10 sigmas). After the noise of 90 db intensity, the time of the latent period slowed down by 22 sigmas and after the noise of 100 db level - by 37.

Electrocardiographic studies, as in previous cases, were conducted before and after the action of low-frequency noise of the three above mentioned intensities. At this time, the nature of the shifts in the heart activity was determined in regard to the systolic index $\left(\frac{p-t}{RR}\right)$, the systoles (p-t) and the diastoles (p-t).

The analysis of electrocardiographic data has shown that the systolic phase of the heart in most experiments (in 23 out of 32) does not change. At the same time, the diastolic phase lengthens in 21 cases out of 32. From this: The lengthening of the entire cycle of the heart activity, the reduction of the systolic index and the slowing down of the pulse by 6-9 and 14 beats per minute after the action of the noise of 80, 90, and 100 db respectively. (see Table)

The trend of shifts in the electrocardiogram after the action of low-frequency noise from 80 to 100 db intensity and the dependeace of the deflection of the diastole indexes and the pulse rate on intensity of the noise stimulation.

1) Отведение	2) Знак	3) Число случаев		6) Интенсивность шума (в дб)	7) Разность относительно исходных	
		4) систола	5) диастола		8) диастола	9) частота пульса в минуту
II	+	8	21	80	+0,08	—6
	—	1	1	90	+0,12	—9
	0	22	10	100	+0,20	—14

Legend: (for table on page 15) 1) Lead; 2) Sign; 3) Number of cases; 4) Systole; 5) Diastole; 6) Intensity of Noise (in db); 7) Difference in comparison to the initial figures; 8) Diastole; 9) Pulse rate per minute.

In our cases, the electrical axis of the heart did not go beyond the angle α (+30 - 60°) corresponding to the normogram.

The arterial pressure of the same persons measured before the beginning and after the termination of the action of the noise stimulant revealed a tendency for lowering the maximum level and increase in the minimum level which is more clearly expressed at the noise intensity of 100 db.

Consequently the analysis of physiological shifts after the action of the low-frequency noise of various intensity points to an agreement of data revealed by different research. We have found the importance of conducting observations for several hours in order to make the conclusions accurate for a full working day.

It has been established by R. I. Chernyak's (1958) research performed under the conditions of acoustic camera that the shift of the thresholds of audibility in silence increases within the limits of 1-2 hours of the action of intensive noise. In the following 3-4 hours the shift levels remain the same. L. N. Tumarkina (1955) obtained analogous results in measuring the thresholds against a noise backgound with the difference that identical levels of thresholds become, in this case, established much sooner. A. A. Arkadievskii (1959) studied the shift of auditory sensitivity after the action of "white" noise with the intensity of more than 100 db under industrial conditions and found a further growth of the thresholds of aud i bility during the last hours of work which he evaluated as an effect of fatiguing action of the noise stimulations.

In our experiments the restoration of the auditory analysers after the action of noise of low-frequency spectrum 100 db in intensity was 28 minutes within an hour, which is 5 times greater at the noise of 90 db and 14 times greater than at the noise of 80 db.

Therefore, there is a basis to consider that these relations, at best, do not change from a noise of greater activity.

We tried to approach the discussion of the described facts from the point of explaining the mechanism of physiological shifts on the part of the central nervous system found after a one-hour-long action of noise of the intensivity and spectrum variants accepted in the observations.

It is known that at the moment of appearance of an intensive noise, there appear the orientating and the defense

reactions of the organism resulting from a stimulation in the central nervous system. The next phase is chacterized by the inhibiting processes and retardation of physiological reactions, which leads to a certain normalization of these reactions. However, a continuous stimulation of the auditory centers irradiates through the subcortical regions and includes the vegetative centers into the general diffused inhibition, which is expressed in a systematic diviation of the vegetative functions from the norm.

In our cases, it is expressed in the impairment of hemodynamics. Thus, in the electrocardiograms we found an elongation of the diastole at an invariable time of the systolic phase and, as a result of this, a decrease in the systolic index and the slowing down of the pulse. The maximum arterial pressure goes down, and the minimum pressure goes up. It can be seen from the data of our research that these phenomena increase with the intensity of the noise factor. There is a basis to consider that these changes are connected with the rise in tonus of the parasympathetic region of the autonomic nervous system.

It is supposed that in the mechanism of the inhibiting effect of noise on the auditory analyser (rise in the thresholds of audibility) and on the length of the latent period in the visuo-motor reaction, the irradiated state of stimulation of subcortical vegetative centers has a particular influence.

Conclusions

1. In studying the action of industrial low-frequency noise of a moderate intensity on the auditory and other functions of the human organism by audiometric methods and by measuring the latent period of the visuo-motor reaction, arterial pressure and electrocardiographic recording, various physiological shifts were revealed which permitted to judge their significance for determining standards of the noise factor in industry.

2. Physiological shifts were found to be most pronounced after the action of low-frequency noise of a 100 db intensity with a considerable retardation in the restoration of the functions.

On these basis, noise of such intensity should be considered as a factor having a harmful effect on the organism.

3. Low-frequency noise of 80 and 90 db intensity may be considered permissible in industry because of the insignificant physiological shifts in the human organism with quick restoration of the functions during the period of aftereffect.

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THE EFFECT OF INTENSIVE NOISE ON THE FUNCTIONAL STATE OF THE NERVOUS SYSTEM

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With the development of engineering, noise in individual workshops of industrial enterprises often reaches a considerable intensity (110-120 db). Such intensive noise may, as it is known, cause definite disturbances in the functional state of the organism, which explains an increased interest in the problem of noise in recent years. In the meantime only the effect of noise on the state of hearing has been most thoroughly studied. But the entire problem of the biological effect of intensive noise on human organism, particularly in its clinical physiological aspect, has not been adequately studied. Until now, the clinical picture of the "noise disease" has not been clearly described, but this acquires a special meaning in solving the problems of examining the ability to work and in the development of therapeutic and preventive measures.

As it has been shown by the research of T. A. Orlova, Ye. N. Iordanskaya and P. R. Vaynshteyn, noise, particularly intensive noise, causes a number of disturbances in the higher nervous activity: A change in the force, steadiness and mobility of nervous processes, disturbances in the interaction signal systems, lengthening of the latent period of the motor reaction. Under the influence of noise, the intracranial pressure rises (Kennedy, M. P. Mogilnitskiy and Warren), the excitability of the vestibular apparatus increases (Bekesy, B. N. Tolokonnikov [doctoral dissertation], Moscow, 1945, and others), muscular tone changes (A. P. Bruzhes and A. A. Arkadyevskiy, R. A. Zasosov and V. F. Undrich), the motor chronaxy lengthens (A. V. Bykhovskiy [Candidate's dissertation, Chelyabinsk, 1948], Toulouse and others), the blood pressure changes (I. I. Galakhov, N. Krylova, Bugard and others). Also there are indications that the functions of some internal organs and the metabolism become disturbed.

We examined three groups of people in industry. Persons of the first group were subjected, on the average, to a daily action of intensive noise of 120 db intensity with all sound frequencies of the spectrum and with the prevalence of high frequencies. Persons of the second group were periodically under the conditions of the same noise. Finally, persons of the third group (156 persons) worked, on the average, under the condition of noise of 95 db intensity (female twisters in kapron industry). In the first two groups the majority of the examined persons were motor mechanics and engineering personnel engaged in testing diesels, chiefly middle-age men. The distribution according to the lengths of work under the conditions of noise (daily effect of noise) in the first group was as follows: From 1 to 5 years - 11 persons (7 of them to 2 years), from 6 to 10 years - 24 persons, over 10 years - 18 persons. In the second group (incidental effect of noise), from 1 to 5 years - 15 persons (7 of them up to 2 years), from 6 to 10 years - 17 persons, over 10 years - 23 persons. The third group consisted of women 18 to 38 years of age whose length of employment was: From 1 to 5 years - 44 persons, from 6 to 9 years - 34 persons and from 10 to 13 years - 78 persons.

We noticed the frequency of functional disturbances in the nervous system among people which we classed in the first two groups, i. e. those who were subjected to the effect of a more intensive noise (120 decibels). Almost in half of them we found disturbances in the central nervous system in the form of astheno-vegetative and astheno-neurotic syndrome and vascular-vegetative dysfunction. The main complaints with regard to the nervous system from persons of both groups were headaches, more frequently localized in the forehead area, irritability, increased fatiguability, and pains in the heart area. Such complaints were present in half of those examined and usually developed 4 or 5 years after the beginning of work under the conditions of noise. Less frequent sere sleep disturbance, sleepiness during the day, increased prespiration and weakness of memory. Some of those persons developed "intolerance" to noise. During the moment of the action of noise, individuals complained of buzzing in the head, pain in the ears, sleepiness, weakness, prespiration and tension in addition to headaches. Some had a sensation of "being skinned", a sensation that the head is bursting and pains in the throat while talking. At the end of the day, they usually complained of fatigue and buzzing in the ears, and some complained of pain in the eyes.

In neurological examinations of persons in both groups we observed the tremor of the eyelids and fingers, the lowering of the corneal abdominal reflexes and sometimes the adjusting nystagmoid. Some persons with a long period of

employment had hypesthesia, and some suffered from hyperesthesia in the distol portions of the hands and feet, and lowering of the vibration sensitivity. The pylomotor reflex was suppressed in mejority of the examined persons. The longer the time of employment the more was the tendency to the lowering of the clearness and length of expressed dermographism (when examining with a dosed dermagraph), and a lowering in the reaction of the oculocardiac and the orthoclinostatic reflexes. Deviations on the part of the vibration sensitivity and the autonomic nervous system occurred more frequently and were more expressed in persons who were subjected to a systematic action of intensive noise and somewhat less frequently in the persons of the second group whose work under the conditions of noise was of a periodic nature.

We were able to conduct a more detailed study of the nervous system in the twisting shop of the kapron industry. 156 persons were given an initial examination before the beginning of the working day.

Changes in the nervous system were detected only in 30% of the cases and were not sharply expressed. Thus, moderately expressed asthenic and neurotic reactions were noticed in 40 persons, astheno-vegetative syndrome - in 4 persons, vasculovegetative dysfunction - in 2 persons, migraine-like syndrome - in 1 person, and vestibulopathy phenomena - in 1 person. The observed asthenic and neurotic manifestations were usually combined with changes in the auditory analyser. The degree of lowering of the hearing for high tones [See Note] was increasing with the length of the work under the noise conditions.

[Note] Observations by L. A. Kozlov.

The majority (as in the first group) complained of headaches. The localization of pains in the forehead area was characteristic. Many complained of irritability and increased fatiguability. There were frequent complaints of pain sensations in the heart region. The frequency of complaints increased in proportion to the length of employment under the noise conditions. Other complaints were not as frequent. Objective deviations in examining the neurological status were less expressed.

In order to reveal the finer functional shifts in the state of the central nervous system we used the olfactometry and the pallestesiometry methods (determination of the thresholds of vibration sensitivity) and studied the latent period of the motor reaction (visuo-motor reaction).

The olfaction was studied by means of the Levy-Elsberg olfactometer in 63 workers who did not have any changes in respect to the nasal mucosa. The threshold of olfaction were determined by rosemary and thymol. In this case 31

persons were examined before work and after 4-5 hours of work under the conditions of noise. It was found that noise does not cause any noticeable changes in the threshold of olfaction as determined before the work. They were not detected even during the work, if we ignore a slight increase of the threshold determined by rosemary in some examined persons. Apparently the noise within the limits of intensity of 95 db does not effect the state of the olfactory analyser, unlike the effect of various toxic agents which cause changes in the functional state of the olfactory analyser as early as in the initial stages of the affection [A. I. Bronshteyn, L. G. Okhnyanskaya, V. G. Osipova (Candidate's dissertation, Moscow, 1957)].

Studies of the vibration analyser was carried out by means of a pallesthesiometer, an electronic device which permits to determine the absolute threshold and distinguishing ability of vibration sensitivity in fingers (usually in the middle finger). According to the A. I. Vozhzhovaya's data, the absolute threshold above 1.7μ is considered elevated, and the distinguishing ability, that is the ability to differientiate the vibration sensation, in the norm up to 8μ. The threshold of vibration sensitivity was determined by us in 156 persons at the frequency of 100 cps.

Part of the female twisters (the first group) worked with machines (twisting No. 3) where a small additional effect of vibration on the hands (frequency of about 150 cps) is possible at the moment of the stopping of the moving spindle. The rest (the second group) worked in the same shop with machines (twisting No. 2) which completely excluded the vibration action on the hands (the spindle was stopped by means of a pedal). Persons who worked on the second twisting were not subjected to vibration earlier.

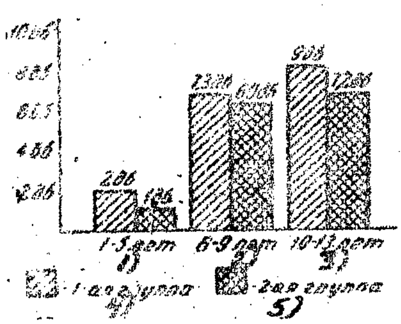
Inasmuch as it is known that the vibration itself causes the lowering of vibration sensitivity, as it was shown through the studies by Ye. Ts. Andreyeva-Galanina, A. I. Vozhzhova and N. B. Metlina, we subjected the data on the state of the threshold vibration sensitivity for individual groups of twisters of the No. 3 and No. 2 twisting to independent analysis. [See following page for table]

It can be seen from the table that the absolute thresholds of vibration sensitivity have, on the average, a small value in persons who were employed for a short time. They increase with the length of employment both in the group which in addition to the action of the noise was periodically subjected to the influence of vibration and in the other group which was subjected only to the influence of noise (see illustration). We did not detect deviations from the normal value in studying the differe ntiating ability of the vibration sensitivity.

Change in average values of the absolute thresholds of the first group depending on the lengths of employment under the conditions of noise

1) Группа крутильщиц	2) Стаж работы	3) Количество обследованных	4) Средняя величина абсолютных порогов (в микронах)	5) Крайние варианты (в микронах)	6) Количество лиц с повышенными порогами (свыше 1,7 μ)
7) Первая	1—5 лет	21 человек	2,8	0,3—13,5	3
	6—9 »	19 »	9,2	0,4—23,1	13
	10—13 »	50 »	13,5	0,29—27,5	40
8) Вторая	1—5 »	23 человека	2,1	0,29—15,3	6
	6—9 »	15 человек	8,5	0,29—19,6	11
	10—13 »	28 »	9	0,38—25,5	19

Legend: 1) Group of female twisters; 2) Length of employment; 3) Number of examined persons; 4) Average value of absolute thresholds (in microns); 5) Extreme variants (in microns); 6) Number of persons with increased thresholds (over 1.7μ); 7) First; 8) Second.



Change in the average values of absolute thresholds of vibration sensitivity (in decibels) in female twisters depending on the length of employment.
Legend: 1) 1-5 years; 2) 6-9 years; 3) 10-13 years; 4) First group; 5) Second group.

Thus, the data obtained by us have confirmed E. A. Drogichina's observations that vibration sensitivity often becomes lower under the influence of noise (the thresholds rise).

The problem regarding the localization of changes in one or the other section of vibration analyser in connection with their peripheral or central end is still open. This problem requires further special investigations. However, it seems to us that the changes which we have discovered are very much like those observed by V. Ya. Lyubomudrov (Candidate's dissertation, Leningrad, 1953) and N. B. Metlina during vibration, when the peripheral end of the vibration analyser chiefly suffers. In our observations, in the presence of comparatively high thresholds, a more complex and finer function of the vibration analyser was preserved - the differentiating ability characteristic of the cortical end of the vibration analyser.

We also studied the state of vibration sensitivity in dynamics before the beginning of work and after 4-5 hours of work under noise conditions. We studied two groups of persons with the length of employment from 1 year to 3½ years - 11 persons, and with the length of employment from 5 to 10 years - 20 persons.

Our observations have shown that in persons with a short period of employment, the thresholds of vibration sensitivity hardly change in the course of a working day (average values before and after the action of noise were 1.7 μ). Among the persons employed for a long time, whose absolute thresholds were higher we observed in 9 persons a tendency toward their increase in the dynamics of a working day. The increase of the threshold amplitude was within the limits of 0.11 to 8.9 μ. In 4 persons, the threshold became lower within the limits of 0.16 to 4 μ and in 7 persons the thresholds remained without change. The average values before and after the action of noise were 7.8 and 9.5 μ.

In most of them, the differientiating ability deteriorated in the course of the working day (after the action of noise). Thus, in 19 out of 31 examined persons, the indexes of the differentiating ability grew from 1 to 6 μ, which in 6 persons the differentiating ability improved (the amplitude lowered within the limits of 1 to 4 μ) and in 6 persons it remained unchanged.

Thus, the fall of the vibration sensitivity (a rise in the threshold) depended not only on the length of employment but also on the effect of noise in the course of the working day.

For the same group (31 persons) we studied, in the dynamics of the working day using chronograph, the latent

period of the motor reaction in response to light and sound signals. The initial value of the latent period of the motor reaction in response to light and sound before the beginning of a working day was more or less the same (within the limits of 17.6 to 36.2 hundredth of a second to light and from 19.8 to 49.5 hundredth of a second to sound).

After working under noise conditions, we observed in most of the examined persons a tendency toward the lengthening of the latent period, however, some of them it shortened. For example, the latent period of the visuo-motor reaction lengthened in 17 out of 31 persons (by 1.9 - 15.0 hundredths of a second), and in 3 persons it shortened (by 2.9 - 6.7 hundredths of a second) and remained unchanged in 11 persons. In response to sound, the lengthening of the latent period occurred in 21 persons (by 1.1 - 12.2 hundredths of a second), in 7 persons, it shortened (by 1.1 - 9.6 hundredths of a second), and in 3 persons no changes took place.

In addition we also examined these persons for differentiation (white light served as a conditioned positive stimulus, and red light - as conditioned inhibition). After 3-5 hours of work under noise condition, the number of errors increased 3 times. Before work, only 7 persons out of 31 made 8 errors, while after work errors were made by 18 persons who made a total of 25 errors.

Thus, we observed in most of the examined persons after their working noise conditions, a lengthening of the latent period in the motor reaction, as well as a disturbance in differentiation.

Conclusions

1. Intensive noise may cause functional disturbances in the nervous system characterized by asthenic and neurotic manifestations. The degree of their expression increases with the increase in the intensity of the noise and the increase in the employment period under noise conditions.

2. A rise in the thresholds of vibratory sensitivity is observed in persons subjected to the action of intensive noise. The differentiating ability is usually not disturbed. In the course of a working day, the absolute thresholds often increase and the differentiating ability of the vibratory analyser deteriorates.

3. Changes in the autonomous nervous system occurring under the influence of noise particularly in persons with a long period of employment, were characterized by the shifts toward the lowering of their reactivity.

4. Under the influence of noise, the value of the latent period in the conditioned motor reaction often lengthens in response to light and sound signals. The developed differentiation is disturbed.

5. The above mentioned shifts in the functions of the higher sections of the central nervous system are evidently connected with the phenomena of fatigue.

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DATA FROM THE CLINICAL AND PHYSIOLOGICAL EXAMINATIONS OF PERSONS SUBJECTED TO A PROLONGED NOISE EFFECT

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Under the conditions of modern industry with maximal mechanization of labor-consuming processes, the application of powerful and highly productive equipment makes noise one of the most widespread factors in the industrial environment having an important hygienic significance. Until very recently the problem of the effect of noise was not frequently considered localistically - only from the point of the pathology of the ear. But a prolonged effect of noise on the state of the central nervous system has not been sufficiently studied, and the data available in literature on this subject are contradictory.

In the present paper we are attempting to clarify the effect of noise on the state of the central nervous system of workmen in nail production. For this purpose, in addition to the usual clinical examination, we applied special clinical physiological methods which, in our opinion, should have facilitated the revealing and understanding the shifts which may occur under the effect of the industrial factor which we are studying.

Noise in nail industry is a main professional harmful factor. Its source is the work of nail-making automatic machines of percussion and pressing action. The level of noise intensity at the working spots of the nail workers fluctuated from 97 to 106 decibels, in most cases being within the limits of 100 - 102 db. When the noises were measured by means of the 1/3-octave analyser LIOT, the maximum of the sound energy fell on high frequencies, chiefly on the frequency zone of 1250 cps. In the process of their work, the nail-makers were subjected to the action of noise throughout the entire shift.

During 1958-59, 153 workers from nail-making workshops of 3 Leningrad factories were subjected to a thorough medical examination under the conditions of the Clinic of

Occupational Diseases of the Leningrad Medical Institute of Sanitation and Hygiene. The study did not include persons (21 persons) whose existing affections of the nervous system could have been caused by other etiological moments (trauma, alcoholism, etc.). We made a dynamic observation (1 year later) of the state of health of 46 persons. The predominant age of the examined persons was 20 to 40 years and the length of service was from several months to 24 years. At the same time we examined 102 workers who, in their age and length of service, corresponded to the group of the nail-making workers but who were not subjected to the effect of intensive noise or other professional factors causing disturbance in neurodynamics.

Describing the state of health of the nail-making workers, it is necessary to mention that two-thirds of the examined persons made various complaints: Headache, dizziness, general weakness, fatigability, sluggishness, disturbed sleep and increased irritability. Subjective disturbances pertaining both to the nervous system and other organs and systems were encountered considerably less frequently.

In an objective study of the state of the central nervous system, we established in the majority of the examined persons the rising or falling of the tendon reflexes, tremor of fingers of out-stretched hands, instability in the Romberg pose, stable red or pink dermographism, increased perspiration and acrocyanosis. Thus, apart from characteristic subjective disturbances, we also observed objectively determined changes in the state of the nervous system in a considerable part of the nail-making workers. All these changes were of a functional disturbance nature. No symptoms of organic affection were observed. Functional disturbances of the nervous system in the observed persons showed in the form of the asthenic and the astheno-neurotic syndromes and vegetative dysfunction. We should mention an expressed correlation of functional disorders in the nervous system of the examined persons who were employed for a long time in nail-making industry: Functional disorders of the nervous system were increasing in number and the degree of severity with the increase in the length of employment.

When the group of workers was examined for the second time a year later, several persons showed a tendency toward a progress of neurological symptoms. A considerable frequency of functional disturbances of the nervous system in the nail-making workers (in more than one-half of the workers) and the connection of these affections with the length of employment, apparently, permit to consider occupational effect of noise as one of the basic factors causing the development of neuroses. It is still more probable because there were 5 times less changes in the state of the nervous system in the control

group than in the workers of the main group.

It should be pointed out that the clinical picture of changes in the nervous system did not have any specific manifestations. Due to this fact, in diagnosing pathological shifts caused by the effect of noise, it is necessary to evaluate thoroughly in each individual case the dynamics of the affection and to study in detail the anamnesis of the patient and the sanitation and hygienic conditions of his work.

In order to study the higher nervous activity in nail-making workers, we applied the speech-motor method with preliminary verbal instructions. According to most of the researchers (N. A. Rokotova, 1954; M. R. Mogendovich, 1954; A. S. Dmitriyev, 1956, and others), the application of this variant of speech-motor method in the process of clinical and hygienic studies is fruitful and promising. This method was used to study the latent period of the conditioned motor reflex in 110 nail-making workers. Light and sound - strong and weak signals, were used as conditioned stimulants.

Because of specific changes in the auditory analyser of the examined workers, the latent period of the conditioned motor reflex to sound stimulants was not included into the development of the problem. Sound stimulant was used to study the relationship between the reactions to strong and weak sound. We are giving the data for the workers of the main and the central groups (see table)

Average value of the latent period of conditioned motor reflex for strong and weak light stimulant (in conditional units).

Length of Employment	Latent Period	
	Strong light	Weak light
Up to 5 years	262	292
From 5 to 10	299	333
10 years and over	347	387
Control	231	259

It can be seen from the table that the average value of the latent period of the conditioned motor reflex to strong and weak light stimulant in workers of the main group regularly lengthens with the length of occupational employment. We could not detect any stable phase states. The lengthening of the latent period of the conditioned motor reflex in the nail-making workers in comparison to the workers of the control group depending on the length of employment, apparently testifies to an unfavorable influence of noise on the state of the central nervous system. The lengthening of the latent period may be considered as a fall of

the agility of the cortex processes. It is most probably connected with the weakening of the stimulation process and an appearance of pathological inertness.

In order to determine the functional state of the central nervous system, we also applied a widespread physiological method used for studying optical chronaxy. In solving the problem, we proceeded from the fact that one of the proofs of reliability in any study is the agreement of results obtained by different methods which explain and supplement each other. It has been established by the studies of many Russian scientists (Yu. M. Uflyand, 1945; F. M. Vasilevskaya, 1955; and others) that the degree of visual chronaxy is determined by the state of the higher nervous centers - the optic zone of the cortex. In studying optical chronaxy, it is possible to obtain definite regularities characterizing the functional state of the central nervous system.

We conducted our chronaxymetric studies with a capacitor chronaxymeter following the method recommended by Yu. M. Uflyand (1941). 108 nail-making workers were observed. We took for comparison the results of the observations for 24 workers of a central group who were almost healthy.

We analysed the obtained data and noted that a considerable part of the nail-making workers (65.4%) had a lengthening of the values of optical chronaxy in comparison to those in the control group. The same regularity was also established in comparing the values of optical chronaxy in nail-making workers depending on the length of their employment. However, the indexes of the optic rheobase in the observed persons were within the limits of the physiological norm, with the exception of 5 persons where its increase was observed.

It has been shown by the researches of Ye. A. Yakovleva (1944) that the lengthening of the chronaxy is caused by the intensification of the inhibition processes in the cortex of the brain. The data of optical chronaxy confirmed the result of clinical studies and studies by the speech-motor method.

Considering the fact that changes in the autonomic nervous system are one of the sensitive indexes of the functional state of the organism, we attempted to study the state of the vegetative function of the central nervous system in the persons under observation. With this purpose in mind, we determined the nature of the thermoregulation reflex following A. G. Shcherbak's method as modified by Ya. Ya. Terner (1939). According to the data obtained by M. I. Sandomirskiy (1951), K. D. Gorina (1954) and others, the thermoregulation reflex is an objective criterion of the state of the vegetative functions of the higher sections of the central nervous system. Thermoregulation reflex was determined in 111 nail-making workers. The results of the observation show that in

the overwhelming majority of the workers (72%) it was pathologically modified, and the rate of the disturbances in the thermoregulation reflex was increasing with the length of employment. The prevailing facts in the pathology of the thermoregulation reflex was its fall or inertness.

Thus, the data of the clinical observations and the physiological methods used by us indicate a disturbance of the neurodynamics in persons who were subjected to a prolonged effect of noise. The shifts which we revealed in the activity of the higher sections of the central nervous system permit, it seems to us, to approach the explanation of the mechanism of appearance of changes in various functions of the organism under the influence of noise. The application of physiological methods helped to objectify the diagnosis of functional disturbances of the central nervous system and served as a reliable aid to clinical observations.

We also considered it interesting to compare the obtained data on the changes in the central nervous system with the disturbances of auditory sensitivity in workers of the observed group, because the provisional sanitary rules for standardizing noise in industry were developed only on the basis of the change in the state of the hearing organ. We studied auditory sensitivity with an audiometer A-2 in 105 nail-making workers whose otoscopic picture was normal.

It was established by this investigation that the workers whose length of employment up to 5 years did not have any expressed decrease in the auditory acuity. With the increase in the length of work, a regular decrease in auditory sensitivity was noted in the person under observation. A more significant decrease was observed in the area of high frequencies (2048, 4096, 8129 cps). The maximum degree of decrease in the auditory acuity was observed at the frequency of 4096 cps.

It follows from our studies, that changes in auditory sensitivity appear in the majority of the examined persons later than the functional changes in the state of the central nervous system. Therefore, this should be considered in determining standards for the industrial factor under study.

Pathological changes found in the workers of the observed group are raising an urgent problem of a radical improvement of the working conditions in the nail-making industry. Preventive measures should be taken along the lines of sound-proofing and sound absorption, as well as the use of individual protective devices. An important role in the prevention of diseases is played by thorough preliminary and periodic medical examinations.

Conclusions

1. The effect of high-frequency noise of a consider-

able intensity may result in disturbances in the state of the central nervous system.

2. The application of clinical and physiological methods makes it possible to establish objectively functional disturbances in the nervous system.

3. Pathological shifts in the state of the central nervous system in the observed nail-making workers appeared considerably earlier than the changes in their auditory sensitivity.

4. The frequency of the detected pathological changes was increasing with the lengthening of the occupational employment, which permits to connect them with a prolonged effect of noise and points to the necessity of special measures for improving working conditions in nail-making industry.

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SOME NEURODYNAMIC FEATURES OF PERSONS SUBJECTED TO THE COMBINED EFFECT OF INDUSTRIAL NOISE AND VIBRATION

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The problem of the effect of vibration and noise on the organism of workers is attracting the attention of numerous researchers. Many of the papers on this subject treat the effect of each of the above mentioned factors on certain functions of the central nervous system separately. However, a joint effect of vibration and noise on the functional state of the central nervous system is treated only by individual authors. At the same time, it is a simultaneous effect of vibration and noise on the workers that frequently takes place under industrial conditions. In particular, the metal casting trimmers are subjected to a combined effect of these factors.

Because of the absence of data on neurodynamic shifts which may occur in metal casting trimmers as a result of the effect of industrial factors, we attempted a study of the functional state of the central nervous system in this group of people. For this purpose we examined 110 trimmers working with pneumatic chopping and calking hammers R-3 and studied their sanitary and hygienic working conditions.

The analysis of vibrograms recorded during various operations in the process of metal casting trimming permitted to establish the fact that the vibration generated by the above mentioned hammers has a comparatively low basic frequency (23-30 cps) and very small amplitudes, and is characterized by the presence of high harmonics. The level of the noise intensity affecting the workers is given in Table 1. /see following page for Table 1/

It can be seen from the data in Table 1 that the noise intensity level during chipping of metal casting may reach a very great value (118 db). It depends on the industrial operation which is being performed and the type of the insert

Table 1

The nature of the noise intensity level in metal casting trimming with chopping and calking hammer R-3 (the maximum permissible level for the spectrum of this noise is 80 db).

Industrial Operation	Noise intensity level (in db)
Trimming with short chisel	100
Trimming with long chisel.	103
Chipping with short chisel	107
Chipping with long chisel.	110
Calking	105
Finishing chipping of the outer surface of the piece.	115
Finishing trimming of the inner surface of the piece.	118

tool. A study of the spectral composition of the noise has shown that its high level of intensity is combined with an unfavorable distribution of the sound energy in the spectrum, whose maximun is situated in the area of high frequencies (2000 cps). This gives reason to consider noise along with vibration as one of the leading professional unhealthy working conditions of this type of industry.

Examination of each workman was preceded by a purposeful collection of anamnestic data. In addition to the complaints regarding the phenomena of a "local nature" caused by the changes in the tissues which took place under the influence of vibration we discovered disorders in the neuropsychic sphere. The workers complained of increased irritability, lack of self-control and quick temper. About half of the examined persons noted occurrence of headaches of various localization and intensity, sometimes accompanied by an unpleasant noise and a ringing in the ears. Part of the workers noted increased fatigability and general weakness after work. The number of complaints characteristic of neurasthenic symptom complex, as a rule, regularly increased with the increase in the length of employment in the capacity of a trimmer.

The group of trimmers under observation consisted, chiefly, of young workmen well developed physically. We did not observe any substantial deviations in the heart, lungs and in the organs of the abdominal cavity when we gave them an objective examination. The changes which we found were chiefly connected with the state of the central nervous system and neurocirculatory disturbances in the upper extremities. No symptoms or organic affection in the nervous system were established. Most of the detected disorders only indicated the presence of functional disturbances (increase, and in some instances a decrease, in tendon reflexes

expressed by slight tremor of the fingers of outstretched hands and of closed eyelids). These changes were accompanied by a general perspiration and a stable red dermographism. The analysis of the obtained material pointed to a tendency toward increased changes in the nervous system with the increase and the length of employment. For control purposes we examined 102 workers of approximately the same age as the trimmers but who, in the process of their work, were not subjected to the influence of factors characteristic of the metal casting trimmers' occupation. It was established in comparing the results of the examination of the trimmers with the data of neurological examination of the workers of the control group, that functional disorders of the nervous system are observed 6 times more frequently in the trimmers than in the persons who were not subjected to the effect of noise and vibration in their work. Thus, the examination results of the metal casting trimmers point to the presence of characteristic subjective and objective disorders peculiar to the neurasthenic syncrome with a number of vegetative disturbances.

The adaptometric method was selected to study the state of higher nervous activity, which made it possible to determine most fully the neurodynamic peculiarities of the observed group of workmen, because the visual analyser is closely connected with other sections of the brain. The dark adaptation was studied with the new Russian adaptometer ADM. Thresholds of light sensitivity were determined every 5 minutes in the course of 1 hour in darkness. In analyzing the results, we proceeded from a number of indexes characterizing the peculiarities of the night vision of the observed persons, such as initial maximum level and the rate of dark adaptation. The degree of "normality" or "pathalogic state" of the darkadaptation curve was determined by comparing with the data on persons with a normal adaptation to darkness. As it was shown by the observations on the group of metal casting trimmers, their light sensitivity differs noticeably from such sensitivity in persons whose state of the dark adaptation is normal. The distribution of average values of the light sensitivity during dark adaptation for the group of trimmers is given in Table 2.
/see Table 2 on following page/

Shifts noted in the adaptometry indicate a low state in the light sensitivity during the process of the dark adaptation in the metal casting trimmers. In agreement with this, a general shape of the curve characterizing the progress of the dark adaptation of the trimmers differs considerably from the control adaptomogram. The adaptation curve for them was considerably lower than the curve characteristic of the control group. A further analysis of the obtained material indicated regular drop in the light sensitivity for the group of trimmers with the increase in the lengths of their

Table 2

Results of determination of sensitivity to light in the process of dark adaptation in metal casting trimmers and in a control group.

1) Время пребывания в темноте (в минутах)	2) Средняя величина световой чувствительности в относительных единицах	
	3) контрольная группа	4) группа обрубщиков
0	30,8	26,2
5	1 730	688
10	23 900	3 140
15	80 800	6 880
20	137 000	10 200
25	181 000	16 100
30	228 000	19 400
35	274 000	22 800
40	308 000	24 400
45	353 000	26 200
50	361 000	26 800
55	444 000	27 400
60	498 000	28 400

Legend: 1) Time spent in darkness (in minutes); 2) Average value in light sensitivity in relative units; 3) Control group; 4) Group of trimmers.

employment in this occupation. According to the research data of a number of researchers (P. O. Makarov, 1952; A. A. Lebedinskii, 1948; B. G. Korobko, 1958, and others), it is possible to assume that, apparently, a considerable extensiveness of inhibition in the brain as well as a certain inertness of nervous processes lies in the basis of lower levels of light sensitivity in darkness for the trimmers of this group. Such a state in the trimmers, it seems to us, may be caused by the prevalence of an inhibition process appearing as a result of a prolonged and sometimes a strong stimulation of the nervous centers resulting from the effect of industrial factors characteristic in this occupation. The degree of changes in the process of dark adoption in trimmers is correlated with the expression of a clinical picture of neurasthenia.

In order to verify the results obtained in the adaptometric study of the state of the higher nervous activity in the metal casting trimmers, we measured the latent period of the conditioned motor reflex by means of an electric chronoscope with the application of 4 stimulants (intensive or weak sound, and strong or weak light). In the process of examining the trimmers, we revealed changes in their sound analyser which are peculiar to those working under the conditions of a considerable industrial noise. Therefore, it was not possible to use the data obtained during the effect of the sound stimulant for determining the value of the latent period of the conditioned motor reflex. It was shown by the analysis of the material obtained under the effect of the light stimuland that the value of the latent period of the conditioned motor reflex in the trimmers to a strong and weak light differs considerably from that in persons taken as a control group (Table 3).

Table 3

Average value of the latent period of the conditioned motor reflex (in conditional units) to strong and weak light stimulant in trimmers and in workmen of the control group

Group	Light	
	Strong	Weak
Control	229	258
Metal casting trimmers	286	342

It can be seen from the data in Table 3 that there is an expressed retardation of the conditioned motor reflex in the trimmers as compared to the workers of the control group. A further analysis of the obtained material indicated definite regularity in the lengthening of the latent period of the conditioned motor reflex with the increase in the length of employment as trimmers.

Table 4

Average value of the latent period for strong and weak light stimulant in trimmers with different length of employment.

Stimulant	Latent period of conditioned motor reflex (in conditional units		
	Employment less than 5 years	Employment 5 to 10 years	Employment 10 years or more
Strong light	276	291	322
Weak light	316	341	371

The results of the study point to the fact that, in the process of measuring the latent period of the conditioned motor reflex, there appeared phase states in a number of trimmers.

The latent period of the conditioned motor reflexes is chiefly, as it is known, one of the physiological characteristics of the agility of the cortex processes. The measuring of the latent period of the conditioned motor reflex permitted us to study the rate of their appearance and progress. We found in the trimmers of the observed group a marked delay of the response reaction to all stimulants we used. This face may be caused by the lowering of the agility of the cortex processes, weakening of the stimulation process and the appearance of pathologic inertness.

Thus, the application of physiological research methods permitted to reveal definite regularities in the change of the functional state of the central nervous system in metal casting trimmers. Considerable noise and vibration accompanying this industrial process result in the chronic fatigue and an exhaustion of the cortex processes in the workmen and, disturbing the functions of nervous activity, cause the development of neuroses.

Our observation of the workmen revealed a number of complaints regarding the impairment of auditory acuity, and noise and ringing in the ears. This fact was a basis for studying the auditory function in the trimmers. 102 trimmers having a normal otoscopic picture were subjected to an audiometric examination. More than half of the examined persons complained of hearing depressions of various degrees. The number of such complaints grew with the increasing length of employment. Audiometric studies in air conductivity revealed a peculiar drop in the threshold curves for the metal casting trimmers. These changes included both the treble and the bass zones of the tone scale of the audiometer (Illustration 1). The most marked depression of the air perception appeared in regard to the high-frequency sounds of 2048, 4096 and 8192 cps.

A study of the depression in the threshold preception of sounds on the length of employment was, in our opinion, extremely essential and important. As a rule, we observed in the workers an impairment in the air perception with an increase in the length of their employment (Illustration 2). It is characteristic that in the trimmers employed up to 5 years with a constant air perception of low-frequency sounds we noted a moderate lose of hearing for high-frequencies with a particular stress for the frequency of 4096 cps. Ya. S. Temkin (1957) and others consider that the failure in sound perception at C_{4096} may be evaluated as an early sign of occupational hearing impairment. In workers employed from 5 to 10 years we observed more marked changes in the air

perception. A still sharper decline in the threshold of sound audibility, both of low and high frequencies, was noted in the trimmers of a 10 year employment and longer. Audiometric studies permitted to reveal changes in the auditory function of metal casting trimmers and to connect them pathogenetically with industrial noise affecting the workers in combination with vibration.

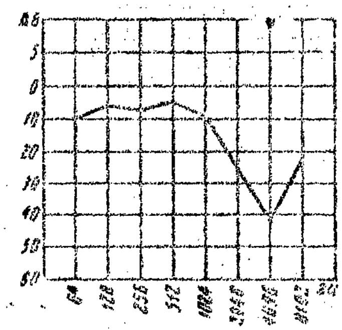

Illustration 1. Loss of hearing in metal casting trimmers according to the audiometric data. The threshold of audibility for normal hearing was accepted as 0 decibels for all frequencies. Along the Y-axis - loss of hearing in desibels; along the X-axis - frequency in cps.

The studies conducted by us permitted to consider that in the case of a simultaneous effect of noise and vibration on workers, there takes place an intensification of their favorable effect. Therefore, the requirements for setting standards for these factors, when they simultaneously effect the workers, should be raised. As an individual means of protection for the trimmers' hearing organs, the ear muffs IGAL padded with the Voyachek mass could be recommended. In the trimming areas it is expedient to build soundproofed resting rooms for the workers for short rests. The design of the chopping and calking pneumatic hammers should include devices for reducing vibration and muffling noise. In selecting employees for work where noise and vibration are present special attention should be given to the functional state of the central nervous system along with

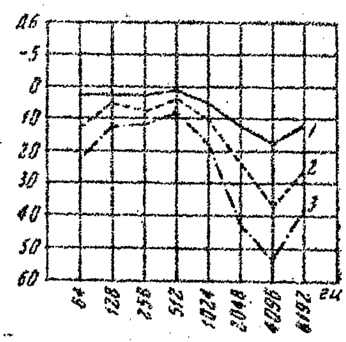

Illustration 2. Loss of hearing in the trimmers depending on the length of employment. The threshold of audibility for normal hearing was accepted as 0 decibels for all frequencies. Along Y-axis - loss of hearing in decibels; along X-axis - frequency in cps. 1 - loss of hearing for less than 5 years of employment; 2 - loss of hearing for 5 to 10 years of employment; 3 - loss of hearing for 10 years of employment or more.

the state of the auditory analyser. During periodic medical examinations of those working with pneumatic instruments it is advisable to conduct audiometric studies in order to reveal initial changes in the functions of the hearing apparatus.

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NOISE MEASURING INSTRUMENTS

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Noise control is becoming more and more important. A successful solution of this problem depends in many respects on the quality of the measuring instruments and the methods of measuring. The aim of their article is to acquaint the readers with some Russian and foreign acoustic instruments, their purpose, and the most important technical characteristics. It is customary to describe noise by the level of sound pressure and spectrum. The level of the sound pressure of noise is measured by an objective noise gauge consisting of a microphone, an amplifier, a rectifier and an indicator. The main characteristics of a noise guage are: Frequency range, irregularity of frequency characteristic, range of the measured levels of sound pressure and the type of corrected frequency characteristics.

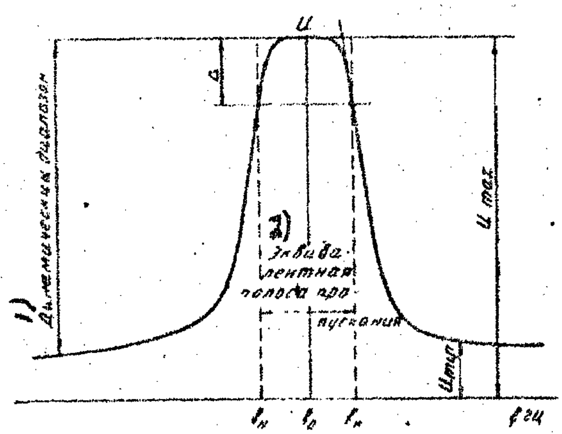
In measuring noises, it is desirable for the noise gauge to have a frequency range from 40-50 to 10,000 - 12,000 cps with an irregularity of the frequency characteristic from ± 2 to ± 2.5 db in the range up to 8,000 cps, and from ± 3 to ± 3.5 db in the range over 8,000 cps. If the noise level is greater than the upper limit measured by the noise gauge, stepped attenuaters of 10, 20, 30, or 40 db which are used as inserts or selectors in the noise gauge system. In using such attenuaters, it is necessary to make sure that the microphone is mechanically strong to sustain increased levels of sound pressure and the value of nonlinear distortions is not greater than the allowable value.

For measuring high levels of sound pressure up to 190 - 220 db, additional microphones may be added to the noise gauge. Such microphones are used in the "Dow Instruments" type 1400 (England) and the "General Radio" type 1551-B (USA) noise gauges.

For approximate measurement of the loudness levels of sounds, objective noise gauges, apart from the linear frequency response ("lin." or "C"), have corrected responses. In the American models these responses correspond to 40 ("A")

and 70 ("B") phons, in the English models developed by King - to 30, 50, 70, 90 and 100 phons, and in the German (FRG) - to DIN 3, DIN 2 ("A"), DIN 1 ("B") and "C". In many noise gauges, the selection of corrections is done by the operator depending on the measured level, which leads to all kinds of incidental errors. A more exact and perfect noise gauge in th this respect is the LIOT noise gauge in which the correction of the frequency responses is done automatically every 10 db for the levels from 30 to 80 phons. Levels over 90 phons (decibels) are measured at the linear response (I. I. Slavin).

Filters, analysers, and spectrometers are used for measuring the noise spectrum. Filters are the main elements in any analysing instrument. Most of the modern filters are based on the use of the resonance phenomenon in electric circuits. The main characteristics of the analysing instrument are: Frequency band, equivalent transmission bandwidth (briefly, bandwidth), dynamic range (attenuation outside of the transmission band), and the incline steepness. All of these values are determined from the frequency response of the filter (its resonance curve), a diagram of which is shown in the illustration. Frequency response can be obtained if we feed sinusoidal constant amplitude voltage and the changing frequencies into the input of the instrument and measure the voltage at the output.



Frequency Response of a Band Filter.

f_o $f_н$ and $f_к$ - midband, lower band, and upper band frequencies.

Legend: 1) dynamic range.
2) equivalent transmission band.

The equivalent transmission bandwidth is the width of such white noise band [See Note] whose energy equals to the entire energy of the corresponding area between the resonance curve and the X-axis, and the level of the white noise spectrum is equal to the maximum level of the resonance curve. In practice, the equivalent transmission bandwidth is considered to be the width of the resonance curve at the distance of Δ-3 db from the top.

[Note] White noise is the noise with even energy spectrum containing all frequencies within the audible range when measuring with a narrow-band analyser (L. Beranek).

The dynamic range of an analysing instrument is the difference between the maximum and the minimum of transmission (expressed in decibels) during constant attenuation.

The incline steepness is characterized by the incline of a tangent to the resonance curve of the filter at the point of its crossing a line parallel to the X-axis at the level of 3 db from the top and is measured in decibels per octave. The steepness of incline is connected with the transmission bandwidth. The narrower the band, the greater is the steepness of incline.

Depending on the width of the transmission band all analysing devices are divided into analysers with a constant transmission bandwidth expressed in cycles per second, and analysers or filters with a constant relative width of the transmission band expressed in percentage of the frequency of tuning. The latter can be either with continuous tuning or stepped tuning. In the latter case they are called analysers or filters with adjacent bands. The analyser differs from the filter in that it has a rectifier and a pointer-type indicator or an electron-beam tube. Spectrometers also belong to the analysing instruments with adjacent bands.

Spectrometer is an instrument in which the spectrum of noise can be observed visually on the screen of the electron beam tube in the form of columns corresponding to a number of frequency bands. The size of the constants of the observed spectrum are usually proportional to the amplitudes of the sound pressure components. Spectrum can be photographed (Ye. Ya. Yudin).

Analysing struments with adjacent 1/3-octave transmission bands are most suitable for measuring noise spectra. Such a band is sufficiently narrow for an approximate determination of discrete components of noise and at the same time sufficiently wide for averaging the fluctuations of the spectrum components of non-stationery noise.

The dynamic range of an analysing instrument should be 5-10 db greater than the difference between the maximum and minimum levels of the noise spectrum components. Otherwise it is impossible to detect and measure the latter.

The greater is the steepness of incline in the filter, i. e. the closer it is to an ideal filter whose incline lines are vertical, the closer is the correspondence of the measured spectrum to the actual one. In the best types of instruments with 1/3-octave bands, this value reaches 60 db and more per octave. The steepness of incline of 25-30 db per octave may be considered satisfactory.

In noise analysis, the greatest amount of time is spent in recording the readings of the instruments and processing the experimental data. The application of automatic recording instruments - high speed sound level recording devices (recorders), considerably reduces this time and improves the exactness of measurements. Recorders together with other instruments permit to take various acoustic measurements. In measuring noises, they are used with noise gauges and analysers for continuous recording of the total level of noise, the noise components and the noise spectrum.

The recorder consists of an input potentiometer, amplifier, recording device, and a synchronous motor with devices for moving the paper and connecting the outer instrument.

If we connect the recorder with a flexible shaft to the limb of the analysing instrument, pass voltage from the output of the analysing instrument to the input of the recorder and turn on the motor, the noise spectrum will be recorded on the paper tape. With the proper selection of speeds for the movement of paper and the turning of the limb, a recording can be made on paper previously lined for frequency. The absolute levels of the noise components and the total level of noise can be determined if appropriate callibration of the instruments is done.

No mechanical connection of instruments is needed for the continuous recording the total level of noise or its components. It is sufficient to connect the output of the noise gauge or the analysing instrument with the output of the recorder and take a recording.

The basic characteristics of the recorder are: Frequency range, irregularity of frequency response, movement speed of paper, speed of recording (movement of the point), and the revolving speed of shaft for connecting outer instruments. A recorder of H-110 type has been developed in the USSR and is now produced by one of the factories of the Leningrad Council of National Economy.

Some foreign firms manufacture composite instruments for acoustic measurements - spectrographs consisting of a noise gauge, an analyser, and a recorder. The spectrograph of the 3310-type produced by a Danish firm "Brüel and Kjer".

The most promising method in noise measurements is the method of magnetic recording with the use of the magnetic

tape-recorder. This method is widely used. A recording of noise is analysed in detail in a laboratory and, if desired, can be preserved for further studies. It is more convenient to make an analysis not for an entire recording but for a part of it which was cut off and made into a ring.

The use of magnetic recording in noise measurements has the following advantages: The available analysing instruments are used more rationally, favorable conditions are created for a centralized interpretation of the recorded noises on stationary automatic instruments, it is possible to take measurements and analyse extremely short processes the noise of which lasts seconds or tens of seconds, to study non-stationary noises during separate short periods of time and the phase relationships of frequency components of noise. Each of the enumerated measurements is done according to a corresponding method.

In order to obtain good results for measurements, magnetic recording should not have substantial distortions in the noise under study. The following characteristics of the magnetic tape recorders are most important from this point of view: Frequency range, irregularity of frequency response, stability of the amplitude and frequency response. A portable tape recorder type-600 or 601 is produced in the USA by the firm "Apex" especially for acoustic measurements. The same instrument is also a noise gauge.

Measuring instruments (noise gauges, analysers, etc.) should be periodically, not less than once a year, checked and graduated in special acoustic laboratories. If the corrections of certain measuring instruments or groups of instruments exceed ± 3 db at individual frequencies, they should be taken into consideration in measurements and calculations.

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NATIONAL AND FOREIGN SOUNDPROOFING STANDARDS

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Until recently there was no single standard method in the USSR and abroad to evaluate soundproofing capacity of protective constructions in buildings. Because of this it was difficult, and sometimes impossible, to compare sound-insulating qualities of constructions studied in different countries.

The most widespread method to evaluate the sound-insulation of protective constructions from airborne noise is to evaluate it by one value of its average sound-insulating capacity (in decibels) in a certain frequency range, more often in the range of 100 - 3200 cps. The sound-insulation of floors from the impact noise has also been evaluated in many countries by one index - by the loudness level of impact noise (in phons) under the floor produced by an impact machine (of different types in different countries) working on the floor, reduced to a general sound-absorption value of the room below, or by a number indicating by how many phons the floor lowers the loudness level of the impact noise in comparison to a standard floor. Because of such methods of evaluating the sound-insulation capacity of constructions, standard requirements for sound-insulating construction have also been expressed in most instances by a single index. Thus, according to the standards, it was required in the instructions for soundproofing many-storied residential buildings (I 1-4-53) that average capacity of floors and walls between apartments to insulate from the airborne noise should not be less than 48 db, and that of partitions between the rooms - not less than 40 db. The loudness level of impact noise produced under a floor under normal operational conditions should not exceed 40 phons.

Such methods for the evaluating and standardizing of

the soundproofing and protective installations were accepted because of their simplicity and sufficient precision for practical engineering purposes in the case of acoustically-uniform constructions. However, for non-uniform constructions which have air space or consist of layers of materials different in their density and resilience, this method of evaluation is not sufficiently exact.

In 1957, the Research Institute of Architectural Physics and Protective Constructions of the Academy of Construction and Architecture, USSR, in cooperation with a special architectural designing bureau of the Moscow City Executive Committee, developed new evaluation methods and standard requirements for soundproofing protective constructions. These standards were included into the revised Par. 7, Chapter IV, of the Sanitation Standards and Instructions and into the instruction for the sound-insulation in residential and public buildings (Sanitation Standards 39-58). The new methods of evaluation and standardization of sound-insulation in structures closely follow the suggestions on a unified method of measuring the sound-insulating quality of structures by the Technical Committee No. 43 (Acoustics) of the International Organization on Standards.

According to the new standard requirements, the capacity of structures to insulate from the airborne sound is evaluated by a frequency response curve in the frequency band of 100-3200 cps. The main criterion for determining the required insulating capacity of protective structures from airborne noise are the curves of standard frequency responses in the same band.

Sound-insulation of the floor is evaluated by a frequency response curve of the reduced sound pressure level of the impact noise under the floor. The required sound-insulating quality of a floor from an impact noise is determined by the curves of standard frequency responses of the reduced sound-pressure level in the range of 100-3200 cps.

Illustration 1 shows three normative frequency response curves of sound-insulating property of structures from airborne noise.

Curve I represents the required standards (average sound-insulating capacity of 48 db) for the walls and partitions between apartments and those separating habitable rooms from stairways and from uninhabitable rooms within an apartment house, floors between habitable rooms, those separating habitable rooms from auxiliary rooms, as well as from uninhabitable rooms within apartment houses, etc.

Curve II represents the required standards (average sound-insulating capacity of 44 db) for the walls and partitions between hotel rooms, walls and partitions between class

rooms in schools, floors between hotel rooms, between inhabitable rooms in rooming houses, etc.

Curve III represents the required standards (average sound-insulating capacity of 40 db) for walls and partitions between habitable rooms in apartments and between habitable rooms and auxiliary rooms (in one-family apartments, an average sound-insulating capacity of 35 db is permissible for such partitions), walls and partitions between habitable rooms in rooming houses, as well as between office rooms in administrative buildings.

Illustration 2 shows two normative frequency response curves of the reduced level of the sound pressure of impact noise under various floors.

Curve IV represents the required standards for floors between habitable rooms separating them from auxiliary rooms, as well as from uninhabitable rooms added in apartment houses, floors separating habitable rooms in rooming houses from common auxiliary rooms and from uninhabitable additional rooms in hotels, floors separating operation rooms and living quarters from other parts of a hospital, etc.

Curve V represents the required standards for the floors between work rooms and those separating workrooms from other parts of the building which are used by the public in administrative buildings, floors between classrooms and floors separating classrooms from other parts of a school (except living quarters) floors between hospital wards and floors separating wards from other parts of the hospital, etc.

In residential buildings of Class II and Class III, it is permitted, until 1961, to have floors which have sound insulation capacity from impact noise in accordance with the standards of Curve V. In the absence of frequency response curves for sound-insulating capacity of protective installations from airborne noise, it is permissible to check their sound insulation according to the average sound-insulating capacity mentioned above.

It should be mentioned that the advantage of the new methods of evaluating sound-insulation standards is the fact that the differentiated approach to the analysis of sound insulation by frequencies permits to evaluate the sound-insulating qualities of protective constructions much more exactly (particularly of those which are not acoustically uniform), and, consequently, to develop more rational and economical types of structures with good sound insulation.

In order to compare the required levels of sound insulation in residential buildings in the USSR and abroad, below we are giving the data of some foreign national construction standards, codes, and recommendations.

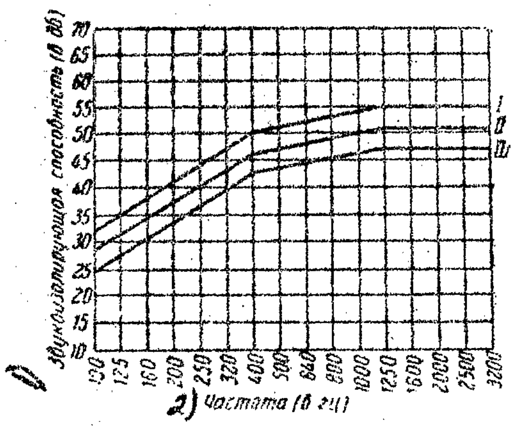

Illustration 1. Normative curves of sound-insulating capacity from airborne noise.
I - normative curve for floors and walls between apartments in apartment houses, etc.; II - normative curve for floors and partitions in schools, hospitals and hotels, and for floors in administration building, etc.; III - normative curve for partitions between rooms in apartment houses, rooming houses and administration buildings.
Legend: 1) Sound-insulating capacity (in decibels)
2) Frequency (in cps).

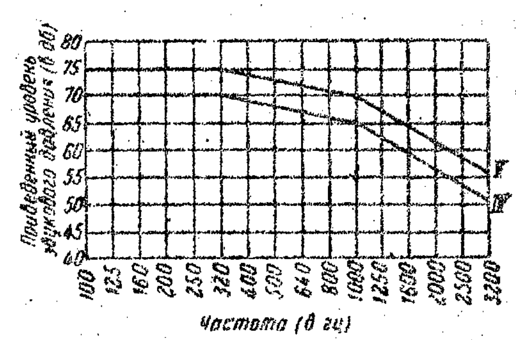

Illustration 2. Normative curves of the reduced sound pressure level of impact noise under floors (USSR)
IV - normative curve for floors in residential buildings of Class I and others; V - normative curve for floors in schools, hospitals, administration buildings, residential houses of Class II and Class III (until 1961) and others.

German Standards. Introduced for the first time in 1958, required a minimum average sound-insulating capacity for walls between apartments of 42 db for frequencies 100-555 cps, and 54 cps for frequencies from 550 to 3000 cps, or 48 db for the entire frequency range. For floors, these standards were lowered by two decibels. In the case of impact noise, it was required that the impact noise level in the room under the floor should be not more than 85 db during the operation of a standard impact machine.

However, in 1953, a new standard for residential buildings was introduced in the German Democratic Republic and the German Federal Republic. It was based on a new method of evaluating sound insulation requiring a definite sound-isolating capacity for all frequencies in the range of 100-3200 cps (Illustration 3). For impact noise, standards were also fixed in the form of a curve for reduced level of impace noise under the floor during the operation of a standard impact machine on this floor for the frequency range of 100-3200 cps (Illustration 4).

Canadian Standards. National Building Code of Canada (part 3) contains a section on sound insulation and requires a definite sound insulation for various types of buildings and quarters. According to these standards, an average sound-insulating capacity of not less than 45 db is required for walls and floors in residential buildings. There are no standards for impact noise.

British Standards. The British Building Code (Chapter 3) contains requirements for sound insulation. They establish the average sound insulation. They establish the average sound insulating capacity of 55 db for walls between apartments, and 35 db for partitions between rooms. The construction of floors in residential buildings should reduce by 15-20 db the level of impact noise in comparison to a plane reinforced concrete slab. For schools, this figure equals to 10-15 db.

However, in 1954, recommendations for residential buildings were published, which proposed to evaluate sound insulation from the impact and airborne noise according to the frequency responses in the same way as in the new German standards (Illustration 3 and 4). Two degrees of sound insulation are suggested both from airborne and the impact noise in residential houses.

Swedish Standards. Average sound insulation capacity of walls and floors in residential houses and hospitals should be not less than 48 db, in classrooms - 44 db, and in offices - 40 db. Accordingly, the value of impact noise insulation for reinforced concrete and wooden floors is 55 and 46 db in residendial houses, 55 and 48 db in hospitals, 50 and 44 db in schools, and 50 and 42 db in offices. The value of impact noise level L is determined from the equation:

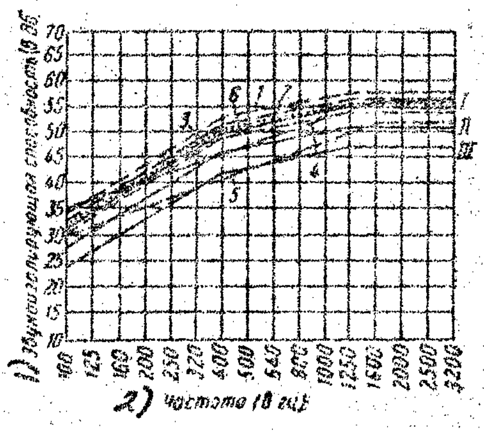

Illustration 3. Normative curves of sound-insulating capacity from airborne noise (USSR and foreign countries).
I, II, III - Russian standards for residential and public buildings.

1 - floors in laboratory
2 - floors in buildings and walls in laboratory
3 - walls in buildings

} German standards for residential buildings.

4 - 1 degree
5 - 2 degree

} British recommendations for residential buildings.

6 - Finnish Standards for residential buildings.

Legend: 1) sound insulating capacity (in decibels).
2) frequency in cps.

$$L = 130 - L_1 - 10 \quad \lg a \quad \text{decibels},$$

where L_1 - noise level measured on the curvilinear scales of the noise gauge; a - average absorption in the room.

Norwegian Standards. Average sound insulation capacity for walls and floors in hospitals and residential houses should be not less than 50 db, for schools - 44 db, and for offices - 40 db. Sound insulation of floors from impact noise should be in all of these cases 12 db better than for a reinforced concrete floor slab without flooring, and the measurements should be conducted at the 40 db response of the noise gauge.

Netherland Standards. The standards have three degrees of sound insulation from airborne noise - good, average, and satisfactory - and are determined depending on the weight referred to a unit of the protective surface.

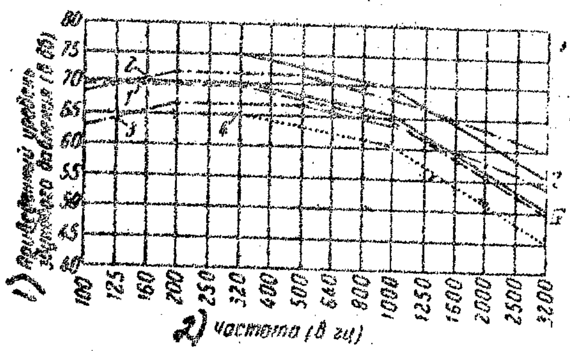

Illustration 4. Normative curves of reduced sound pressure level of impact noise under floor (USSR and foreign countries).
IV, V - Russian standards for residential and public buildings.
1 - German standards for residential buildings.
2 - 1 degree } British recommendations
3 - 2 degree } for residential buildings.
4 - Finnish standards for residential buildings.
Legend: 1) reduced level of sound pressure (in decibels).
2) frequency (in cps).

USA. There are no standards, but only recommendations (1957), which are given in a table.

Recommended Standards (in decibels) for Sound Control in Residential Houses in the USA.

1) Тип шума	2) Перекрытия	3) Класс 4) А (стандарт)	5) Б (минимальный)
6) Воздушный	7) Стены и перекрытия, отделяющие общие комнаты и спальни в одной квартире от общих комнат, спален и кухонь в другой квартире, должны иметь среднюю звукоизолирующую способность	50	40
	8) Все другие стены и перекрытия должны иметь звукоизолирующую способность	45	40
9) Ударный	10) Все перекрытия	15	10

Note. Sound insulation from impact noise is determined as a reduction in the impact noise level under the floor in comparison to a 4 - decimeter reinforced concrete floor.

Legend: 1) Type of noise; 2) Attenuator; 3) Class; 4) A (standard); 5) B (standard); 6) Airborne; 7) Walls and floors separating living rooms and bedrooms in one apartment from living rooms, beedrooms and kitchens in another apartment should have an average sound-insulating capacity; 8) All other walls and floors should have the sound-insulating capacity of; 9) Impact; 10) All floors.

Finnish Standards for Residential Buildings. The method of evaluation is the same as the new German method.

Czecho-Slovak Standards. Walls between apartments and floors are required to have an average sound insulating capacity of 48 db, and partitions between rooms - that of 40 db. Impact noise level under the floor should not exceed 85 db when a standard machine is operating on the floor.

When we consider the above-mentioned standardization methods and the sound-insulation standards in the USSR and abroad, it is possible to establish that: 1) The majority of the foreign countries are still following the old method of evaluating the sound-insulation of protective installations from airborne noise by the average sound-insulating capacity. 2) On the average, all countries require an average sound-insulating capacity of 49 db for walls between apartments and floors, which is in agreement with our old standard of 48 db. 3) Because of the different methods of evaluating impact noise, there is a considerable disagreement in foreign countries regarding normative requirements. 4) Only the German Democratic Republic, the German Federal Republic and Finland have developed new normative requirements in the form of frequency responses of sound isolation, both from the airborne and the impact noise, for residential buildings. In England, there are only recommendations for the standardization of sound insulation in the residential buildings by the frequency response method.

Finland has more rigid requirements for the insulation of floors from impact noise than the USSR and Germany. The sound control requirements for airborne noise are approximately on the same level.

Thus, the USSR is noticeably ahead of other countries in regard to the new methods of sound control evaluation, and particularly in regard to a detailed standardization for buildings of various purposes.

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SOME MEASURES TO ABATE MOTOR TRANSPORT NOISE

By V. Ye. Koshkin

In view of a considerable increase in the number of automobiles in the country, automobile noise became an important factor in general street noise of big cities. Studies have shown that the level of noise, for example in Moscow, on main streets during the peak of traffic reaches approximately 100 db. It has been established that a high level of noise is created chiefly by trucks, particularly MAZ-200 and MAZ-205, which increase the general level of street noise by 7-8 db, and by busses. The presence in the noise spectra of these automobiles of components having high intensity in a wide frequency range gives it a characteristic which is very unpleasant to the ear.

Automobile noise depends mainly on the level and the frequency composition of the engine's noise and on the degree of muffling the noise of the engine's inlet and exhaust. The rear axle, gear box, tires, vibrating surfaces of the cabin and the hood should be considered as other sources of automobile noise. Sources of vibration are usually the engine, propeller shaft and other units.

In practice it is customary to evaluate automobiles according to the level of external noise and the noise in the cabins and hoods. It is known that the level of noise of modern passenger automobiles is not high, is of low frequency in nature, and, therefore, harmless. The complex of constructive decisions directed to the maximum abatement of the noise of passenger cars is, as a rule, sufficient to satisfy the minimum health standards. At the same time, the levels of noise from trucks (outside and in the cabin) are exceedingly high.

There existed a view point according to which a number of constructive decisions which were successfully applied to passenger automobiles (hermetic sealing of the cabin, application of antivibration covering and sound-absorbing covering for the cabin, highly efficient mufflers for intake and exhaust, etc.) However, in connection with the replacement of old automobiles with new models, more and more attention is

given to the necessity of a substantial reduction of noise from passenger automobiles and trucks. A number of measures is carried out in order to reduce the noise of engines and automobiles. Let us discuss some of them:

1. Improvement of intake system of the engine. It is known that one of the most intensive sources of noise in the engine is the intake system. The cause of the formation of the so-called intake noise are the vibrations in the intake system of the air stream which enters the cylinders of the engine. Almost all engines of passenger automobiles are supplied with mufflers for the intake noise. Usually they are constructed as one unit with air filters. However, mufflers for the intake noise are not being used in trucks. According to two frequency spectra shown in Illustration 1a, the application of a combined muffler and air filter unit secures the muffling of the noise component of the engine in a wide frequency range for 10-20 db.

2. The abatement of the exnaust noise of the engine. The exhaust system of the engines of passenger automobiles never cause any unfavorable criticisms, but the exhaust noise of truck engines frequently prevails in a general automobile noise. The designers' desire to make an inexpensive and durable muffler, simple in design, and not causing great losses in the power of the engine because of the counterpressure created by it at the exhaust and not reducing the fuel economy of the engine often results in its inferior acoustic qualities.

As experience has shown, it is almost always possible to find a rational solution which would most fully satisfy the controdictory requirements for the muffler design and would secure the necessary muffling of the exhaust noise. The muffler used in the automobile MAZ-200 lowers the general level of the exhaust noise of the engine YaAZ-204 only by 11 decibels. Experiments have shown that with a different muffler, the level of the exhaust noise may be lowered by 21 db and the frequency of the composition of the noise may be substantially changed (Illustration 1,). However, it should be stressed that such a substantial abatement of the exhaust noise in the engine YaAZ-204 still will not secure the required abatement of the overall automobile noise because the noise level of the supercharger in the engine is high. It means that it is also necessary to raise the effeciency of the muffler at the intake of the supercharger.

It is known that the first models of the ZIL-158 busses has a very unpleasant exhaust noise. The application of an additional expansion chamber in the exhaust system lowered the noise level by 3 to 5 db and noticeably changed the frequency composition of the noise.

3. Improvement of the fuel supplying unit and the working process in diesels. The experience of foreign engine-

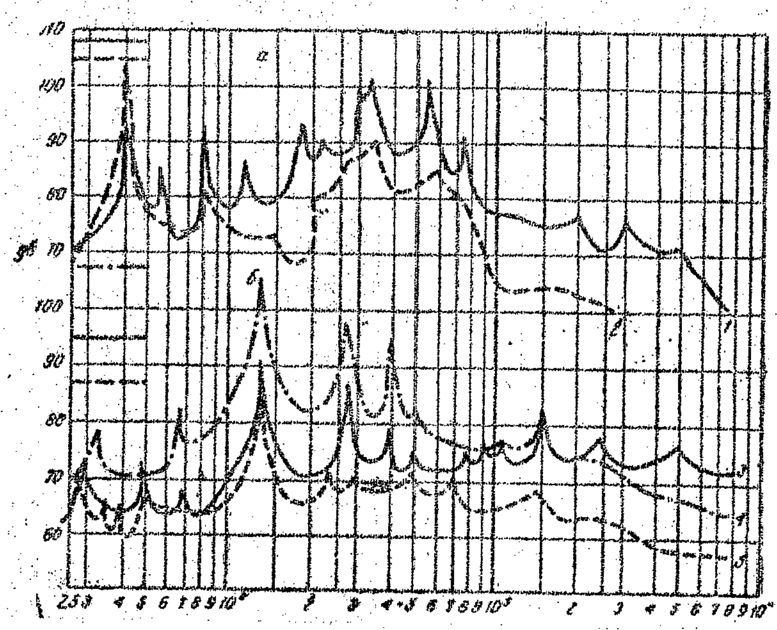

Illustration 1. a - Noise spectra near the air intake nipple of an experimental four-cycle automobile diesel: 1 - Without air-filter; 2 - with air-filter; б - At a distance of 5 m from the exhaust pipe of the engine YaAZ-204; 3 - with serial muffler; 4 - without a muffler; 5 - with an experimental muffler.

building shows that it is possible to abate considerably the noises produced by automobile diesels by improving the fuel-supplying units and the operational conditions of the engines. For example, in the diesel MAN with the M-process, in which a relatively slow evaporation of fuel takes place in the initial moment, and in comparison with the usual process the increase in the pressure is more even, the stiffness and noisiness of the operation was reduced. The engines MWM with a direct injection, with an ellipsoid changer in the piston and a well fitted precombustion chamber do not produce much noise.

4. Improvement of the designs of fans and superchargers. This problem has become of particular importance in connection with the development of desibels with turbosuperchargers and aircooled carburetor engines with whose noise is higher than that of the water-cooled engine. From the point of reducing

the noise, tangible effect is achieved by the use of fans with unevenly distributed blades, as well as fans made of plastic materials. It will be necessary to develop and use highly efficient mufflers for turbosuperchargers.

5. Improvement of the spring suspension device for the engine. The vibrating panels, floor and roof of the cabin and hood usually create intensive and unpleasant noise in the cabins and the hoods of the automobiles. The source of these vibrations is chiefly the engine, therefore, by reducing the level of the engine's vibration it is, also, possible to lower the level of the noise. It has been noticed that the automobile "Moskvich-407" makes considerably more noise at the speed of 70 kilometers per hour. Measurements have shown that under this condition of the engine, the vibrations of one of the supports of the engine sharply increase and are transmitted to the hood. It is possible to remove this drawback by introducing a more resilient suspension device for the engine. A reduction in the vibration of the floor, roof and the panels of the hood or the cabin may also be achieved by making them sturdier. However, this belongs to the problem of developing more rational designs for cabins and hoods.

6. The application of sound-proofing and sound-absorbing materials and antivibration coverings. These measures which were formerly used on passenger cars for the hoods are now also widely used for the cabins of trucks.

Experimental work has shown that a substantial decrease in the level of noise in the cabin of a truck can be achieved only by a combined application of all methods of soundproofing and sound-absorption. In order to give a rough idea of the effectiveness of the above mentioned measures, we are giving the results of testing the automobile MAZ-200 with an experimental four-cycle diesel of 180 horsepower. A diagram of noise insulation of the cabin of the automobile MAZ-200 is given in Illustration 2. The ceiling and the back wall of the cabin are covered with soft polyurethan 20 mm in thickness and perforated cardboard. The front panel separating the cabin from the engine compartment is covered with industrial felt 12 mm thick. The felt is covered on the outside with smooth cardboard. The door panels are also covered with soft polyurethan. The inner door panels are perforated. The diameter of the holes in the door panels and the cardboard covering is 4 mm. The pedals are fitted with crimped rubber cuffs and the sealing washers. The floor of the cabin and the hood of the engine are covered with an antivibration covering. The materials, on the one hand, used here insulate the cabin from the noise of the engine, and, on the other hand, reduce the vibrations of the cabin and absorb to a considerable degree the sound waves penetrating into the cabin. As it can be seen

from the data of Illustration 3, the intensity of the noise components in a cabin with an increased noise insulation was reduced practically in the entire measured frequency range.

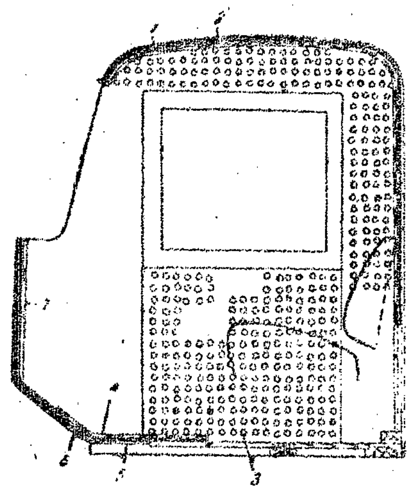

Illustration 2. The diagram of noise insulation in an experimental cabin.
1 - Polyurethan; 2 - Perforated cardboard; 3 - Perforated door panel; 4 - Rubber mat; 5 - Antivibration covering; 6 - Felt; 7 - Cardboard.

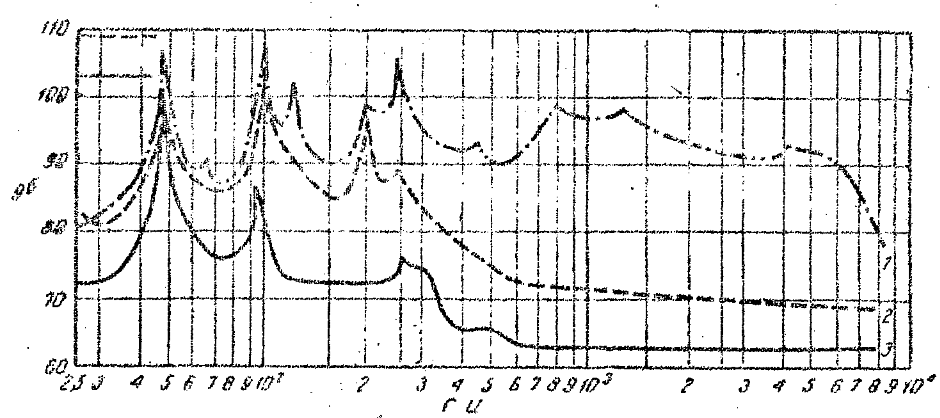

Illustration 3. Noise spectra in a serial and in a noise-insulated cabin of automobile MAZ-200 with an experimental four-cycle diesel.
1 - Diesel noise spectrum; 2 - Serial cabin; 3 - Noise-insulated cabin.

In an overall solution of the problem of reducing automobile noise, the problems connected with the development of unified methods of measuring and evaluating the noise of engines and automobiles, and supplying laboratories and designing bureaus of automobile factories with electroacoustic instruments become particularly important.

The development of evaluation parameters for noise and the introduction of them into engineering conditions and characteristics will help to improve automobile designs.

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CERTAIN PROBLEMS RELATIVE TO THE CONTROL OF URBAN TRANSPORT NOISE

By N. P. Plotnikov

In recent years because of the increasing volume of transportation of various types of freight, there is a considerable increase in Moscow in the number of trucks and passenger automobiles, in the fleet of passenger transportation service and automobiles for special purposes. There is a noticeable increase in the power of the automobile engines and in speed of traffic. In many instances, city street crossings and some squares became centers of very high levels of noise reaching or even exceeding 90-95 db. It should also be noted that these noises are not of short duration, but continue for a rather long time in the course of the 24-hour period, thus creating conditions unfavorable for the health of people around. Therefore, effective noise control is an important and urgent matter.

Some progress has been made in this respect in recent years. We would like to tell briefly about the control of urban transport noise in Moscow.

The executive Committee of the Moscow Municipal Soviet of Working People's Deputies gives special attention to the problems of noise control in the city. The problems of the noise rate in Moscow are chiefly studied by the public-health and epidemiological station, the Architectural Planning Administration, and by some offices and departments of the Moscow City Executive Committee.

From the beginning of 1955 a coordination committee has been organized at the Moscow City and Epidemiological Station. This Committee includes representatives from a number of research institutions and organizations of Moscow which are engaged in the problems of acoustics.

From the middle of 1956, a mobile laboratory, noise control station was organized at the acoustics laboratory of the Architectural Planning Administration. This laboratory is a research organization which has on its staff specialists on the measuring of levels of noises and vibrations of residential, industrial and other civilian buildings and structures,

as well as city noises, and a group of specialists on the development of constructive decisions for the principles of noise control and recommendations for specific objects.

The abatement of noise in the city is achieved by carrying out organizational and technical measures.

The organizational measures include first of all the prohibition to use, as of August 1, 1956, sound signals by any type of urban transport, as well as by river vessels and railroad locomotives when they are in the city limits. This measure which was also recognized as expedient for other cities of the Soviet Union, at one time evoked doubts and objections by a number of city executives who considered that the prohibition of signals will result in an increase in traffic accidents. However, this did not happen. Experience has shown that the rate of accidents even reduced and the number of accidents resulting in death also reduced considerably.

It was also decided to carry out other measures prohibiting the traffic within city limits of automobiles, motorcycles, and other motor vehicles with internal combustion engines without mufflers, the traffic of motor vehicles with loose sidings and carrying containers producing noise (cans, cylinders, etc.), adjustment of sound signals, brakes and repairing of automobile engines on the streets and in courtyards, the use of small carts, horse driven vehicles which have metal-tired wheels. The work of stations for testing automobiles and other engines without using the necessary mufflers, and parking of automobiles in the courtyards of residential buildings without an appropriate permit. Transport departments intensified their control over the mechanical condition of the rolling stock and began to take the necessary measures in repairing the damaged seams and unevenly worn rails of the street car lines.

The carrying out of the organizational measures played a positive part in controlling the noise in the city. Although this big and complex problem is still far from being solved.

As for the technical measures in the abatement of noise, their development often presents great difficulties mainly because of insufficient theoretical study of many acoustic problems and because of absence of verified methods for abating the noise from machines and mechanisms. Nevertheless, many measures have also been carried out in this direction. For example, they began to use for the streetcars of the RVZ-type rubberized tires, rubber lining in the spring supporters of the streetcars and traction motors. The results were promising and, therefore, it is planned to apply this measure to other types of streetcars and the subway.

A new design for the current collector of the trolly busses is being introduced. The head of this current

collector produces less noise when it slides along the contact wire. Trolly busses on several routes have already been outfitted with such current collectors. Elastic systems of suspension supports are being used for the contact wires for the streetcars and trolley busses and the designs of special parts have been improved (the cross connections, intersections, the intake and output switches, etc.). Such improvements aid in reducing the noise from electric transportation. At the present time a suspension system such as this is being used for the major part of contact wires. In maintaining streetcar transportation a great number of damaged rail seams is being repaired. Unevenly worn rails are being mechanically repaired, elastic paddings are installed under rails, etc.

By expanding and improving centralized freight movement by trucks, it was possible to reduce considerably the freight traffic in Moscow and relieve thousands of vehicles.

The introduction of specialized motor vehicles, for example vans for various purposes, and a wider use of motor vehicles for small freight contributed to the abatement of noise.

In automobile enterprises, experimental work is being done on muffling the MAZ-205 diesel engines. A new technology for repairing propeller shafts has been developed and more than 40 fuel-adjusting workshops have been reconstructed and outfitted with a more perfected equipment which permits to adjust the fuel feeding devices. This particularly contributed to reducing the smoke and noise of automobiles.

When the conditions of supplying spare parts improved, the replacement of worn out parts which were the source of increased noise was started. However, this is not done on a full scale as yet.

The abatement of the street noise in Moscow and in other cities is achieved not only by the organizational and technical measures, especially intended to solve this problem, but also by fulfilling a number of tasks having other aims. They, however, also contribute to the reduction of noise disturbances. For example, in Moscow, as it is known, the subway has developed greatly and at the present time it accommodates about 1-third of the commuters, or almost 1/2 if calculated in passenger-kilometer. If we imagine Moscow without a subway we can say with assurance that its main streets would be filled with street traffic and the level of noise would be many times higher than now. The expansion of the subway system aims chiefly at providing the population with rapid and quite comfortable transportation service, and at the same time it contributes considerably to the reduction of the noise in the city.

Great attention is given by the city organizations to

plant green plants. Every year in Moscow great numbers of various types of trees, shrubs, etc. are planted. It is true that this planting is done for a different purpose, but, along with this they often partly solve the problem of noise abatement, because in many cases the plants serve as a kind of noise barrier which hinders the penetration and spread of noise.

It is also possible to mention other measures which reduce noise: Removal of streetcar traffic from the main streets with heavy automobile traffic, expansion of the street system with improved covering, construction of new and reconstruction of old bridges and overpasses, construction of intersections on streets at various levels, and also the construction of routes around the city. All these and other constructions are done on a big scale in Moscow.

There is also basis to believe that the noise created by the city transport is in a definite connection with the accepted system of regulating street traffic. If we take into account that the highest level of noise is created at intersections at the moment when the light signals change to green, i.e. when a simultaneous movement of accumulated automobiles starts, then it becomes clear that an unhindered movement of these automobiles through the intersection should sharply decrease the noise on the street.

In connection with this on some main streets in Moscow a coordinated system of regulating street traffic has been recently introduced. It is based on the "green wave" principle, according to which the traffic, at a certain speed, can more without being delayed at intersections. This system of regulating traffic is being used at many intersections with traffic signals.

However, in spite of the measures which are being taken, the level of the city noise is still high and, unfortunately, continues to increase which is greatly influenced by the increase in the street traffic and the use of high-power vehicles. Vehicles with a two-cycle diesel engine are particularly noisy.

Within the past 10 years, the number of vehicles has almost doubled and the maximum noise level increased, accordingly, by 12-14 phons. According to the data from the acoustics laboratory of the Construction Research Institute of the Academy of Construction and Architecture, USSR, and the acoustics laboratory of a special bureau of architectural design of the Architectural Planning Administration of the Moscow City Executive Committee, who took measurements in 1956, it has been established that the streets of Moscow may be divided into three groups according to the degree of noise: 1) main streets having an average level of the sound pressure of noises of 85 db, 2) secondary streets connecting residential

areas - 78 db, 3) streets and alleys connecting individual blocks - 68 db.

The average level of the sound pressure of city noise on all streets in a 24-hour period is 78 db, and the sound pressure of noises at night is, on the average, 10 db less than that during the day.

At individual points of the city the sound pressure levels of street noises during the day reach 90 or more decibels, as for example at the October Square, Sadovo-Sukharevskaya Street, Sadovo-Chernogryazskaya Street and other streets. An increased noise is observed at the intersections with intensive traffic whenever the traffic begins to move after the signals changes to "go". At these moments the noise level reaches 100 or more decibels.

In solving problems of the abatement of the noise from city vehicle traffic, the organizations of the Moscow City Executive Committee often encounter great difficulties caused by the fact that the excessive noise created by various types of vehicles cannot be eliminated by the organizations which are using them, because such noise is organically connected with the construction of the vehicle. However, industry does not always give due attention to the problem of reducing noise in designing new vehicles. The underestimation of this problem, for example, made it necessary to remove ZIS-154 busses from operating in the city because of excessive smoke and intensive noise.

At one time, a proposal was made at the committee on standards regarding the necessity to include automobile noise standards into the State National Standards. However, industry apparently does not have any appropriate instructions solving this problem, although it agrees with this proposal in principle.

In reply to an inquiry about the work done by them on reducing automobile noises, the Automobile and Automobile Engine Research Institute (NAMI) states that only since 1959 construction and experimental projects for developing mufflers for trucks of new models have been included into their long-term plan.

In solving the problems of noise abatement, great difficulties are presented by the absence of the approved standards for permissible levels of street noises, which does not permit the organizations operating motor vehicles to determine the fitness of transport vehicles and the mechanisms used by them on a technical basis. This fact also does not permit to make valid demand of them in this respect. As early as in 1954 the Executive Committee of the Moscow City Soviet of Working People's Deputies presented the Academy of Sciences and the Ministry of Public Health of the USSR as well as research institutions working on acoustics, with a problem regarding the

necessity to develop such standards. However, this did not go beyond developing variants of the draft of standards, which were later rejected because of their unsatisfactory content, and standards, as yet, remain undeveloped.

What proposals could be made on the problem of reducing street noises which are created by city vehicles? In our opinion they consist of the following: It is necessary to request of the Academy of Sciences, USSR, the Ministry of Public Health, USSR, and research organizations to develop in the shortest possible time standards for permissible levels of street noises, as well as the noises created by city vehicles produced by machine building plants.

In accordance with this, it is necessary to make demands upon industry regarding the limitation of noises created by transport vehicles and their aggregates. These demands should approximately consist of the following: a) development of a more perfect systems of engine muffling, transmission elements, metal body and other elements; b) a wider use of materials in making machine parts which produces less noise in operation instead of metal, such as plastics and rubber articles, and in respect to spring suspension - pneumatic and hydraulic systems; c) rapid assimilation of serial production of wheel-pairs with rubberized tires for rail transport; d) development of a more perfect antinoise mastic and its wide use in urban transport vehicles; e) development and mass production of vehicles of small and medium load carrying capacity intended for moving small consignments of freight of various classification; f) development of capacious and less noisy passenger vehicles for public transportation.

Since it is practically impossible to render vehicles completely noiseless, and intensity of traffic is constantly growing, the level of noise on the streets, it should be assumed, will remain higher than that permissible for residential and public buildings. Therefore, the architects, designers and building material industries should be required to develop reliable sound-proof constructions and construction components.

It is also necessary for the Institute of Complex Transportation Problems of the Academy of Sciences, USSR, and other research organizations concerned with the study or road and vehicle construction to include into their plans studies on the problems directed toward noise abatement in the city, for example; a) determination of an optimal number of vehicles in the city which can be permitted per person of the population, per 1 kilometer of the street system, per square kilometer of the city area, and other indexes; b) search for new means of transportation which would create less noise in operation. For example, the possibility of using in big cities monorail railroads, gyrobusses, air transportation, etc.; c) study of problems of a wider use of railless electric transportation

for passenger and freight; d) use of materials for road covering which would reduce the noise, for example old rubber, foam, inflated and plastic materials; e) study of the effect of regulating street traffic on the condition of noise in the city and development of appropriate recommendations, and a number of other problems.

On the basis of available experience in street noise control, it may be possible to recommend: a) for the transport organizations of the cities to increase their control over the mechanical state of vehicles put into service, and to take due measures for repairing and maintaining streetcar tracks and contact wires of streetcars and trolley busses; b) to introduce widely the elastic suspension system of the contact wires of streetcars and trolley busses, which not only aids in reducing noise but also reduces the level of radio interference and improves the collection of current; c) to use in railless transportation motor vehicles of protective designs producing little noise while in motion; d) to help in every possible way the broadening of centralized transportation and use of specialized vehicles with small carrying capacity; e) to improve the system of regulating street traffic. For big cities with heavy traffic, to introduce the coordinated system of regulating city street traffic; f) to take into consideration that in building subway lines, its stations should not be built in residential buildings; g) at intersections with heavy pedestrian and vehicle traffic, to build crossings at different levels; h) the reduction of noise level in construction areas can be achieved by planting green plants; i) to raise the qualifications of the operators of vehicles of city transportation.

In our opinion an appeal should be made to all engineers and other technical workers engaged in designing and manufacturing vehicles, as well as to those engaged in city construction and services, to give more attention to the problem of noise control, remembering that the creation of quiet conditions for the residents of the city is the duty of the Soviet engineers and architects.

In conclusion, it is necessary to mention that the problem of noise control in big cities is, at present, one of the urgent problems requiring a prompt and all around solution. It should be successfully solved by combined efforts of research organizations, industry, and operational enterprises.

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STUDY OF NOISE BACKGROUND IN SVERDLOVSK

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The purpose of our study is to determine the levels of the sound pressure of noise on the streets of various functional designation. The study was done at 37 points in the city. Noises were measured from 8 AM to 10 PM by means of the ShI-1 noise gauge. Along with determining, the average and the maximum sound pressure level of noise, at the points of observation, we gave a description of individual types of vehicles and studied the effect of the street width and the height of the buildings of the level of the sound pressure of noise. When the noise intensity was measured we inquired from the residents of houses situated on the red line of a narrow street with heavy traffic of various types of vehicles (rail transport, passenger automobiles and trucks).

The data analysis of 3197 measurements at 37 points gives the following distribution of points by the rate of noise: below 55 db - 2, 55-60 db - 11, 61-65 db - 7, 66-70 db - 9, 71-75 db - 3, 76-80 db - 5 [See Note] . Distributing the obtained data by the streets of various designation, we obtained a clear picture of their differences in respect of noise (Table 1)

[Note] The values given by the author are apparently understated, because the ShI-1 noise gauge is not a sufficiently precise instrument. - Editors.

Table 1

Designation of Street	Level of sound pressure (in decibels)
Residential streets	Below 55
Streets of local traffic. . .	56-65
Streets of regional traffic .	66-70
City's thoroughfare streets .	71-80

Comparison of our data with the data of studies by I. L. Karagodina and G. L. Osipov in Moscow and Kh. V. Staroshchuk in Lvov establishes its fact that the value of sound pressure of noise on the main streets of Sverdlovsk is somewhat lower than in Moscow and Lvov. Thus, according to the data of the above researchers, the average sound pressure level of noise on the main city thoroughfares in Moscow is 85 db and in Lvov 81-90 db. On main streets of regional importance it is 78 and 71-80 db respectively. On the streets of local importance, it is 68 db in Moscow and 61-70 db in Lvov. On residential streets of these cities the noise level was less than 60 db.

The average level of the sound pressure of the street noises in Sverdlovsk during the day is 66 db. Within the day, the level of the sound pressure of noise does not change significantly, dropping toward evening only by 5-10 db. The maximum values of average noise levels were obtained on the main streets and particularly at their intersections (on the squares where main streets cross). Individual sections of streets are the noisiest in Sverdlovsk, such as sections of Sverdlov Street, May Day Street, Libknekht Street, Mamin-Sibiryak Street and others.

The measuring of the sound pressure level of the noise produced by individual types of transport vehicles was done at the curb of the sidewalk 5-6 meters away from the line of traffic. For each type vehicles we measured 30-40 items of the same type.

The data of our measurements are given in Table 2.

Table 2.

Types of city transport	Level of sound pressure (in db)	
	Average	Maximum
3-car streetcar	85	87
2-car streetcar	84	85
Riga or Czech streetcar	75	81
Passenger automobiles	65	75
Trucks	80	95
Trolleybus	66	70
Busses	75	80
Motorcycles	80	81

From Table 2 it can be seen that the noisiest types of city transportation are 2-car and 3-car streetcars and trucks.

In order to study the effect of the height of buildings on the intensity of noise level, we took measurements at two sections of streets of the same width but with different building heights. It has been established by this study that when the height of buildings increases from 2-3 floors

to 4-6 floors, an increase of the average levels of sound pressure by 4-5 db is observed.

The increase in the noise intensity with the narrowing of the street even in the case of low buildings of 1-2 floors and lesser traffic was clearly expressed in comparing the noise levels on Lenin Street and Eighth of March Street (Table 3).

Table 3

Street Name	Width of street (in meters)	Number of autos passing, 1 hr.	Level of sound pressure of noise (in decibels)
Eighth of March	25	186	70
Lenin	62	258	64

As it can be seen from Table 3, the average level of sound pressure on the Eighth of March Street is almost 10% higher than on Lenin Street, while the number of transport units passing along this street in an hour is 28% less.

The noise characteristics of narrow streets of the Eighth of March Street type stresses the unfavorable conditions for the residents of apartments whose windows face such streets.

The questioning of persons living in houses situated on the red line of a narrow street with a heavy traffic of city vehicles permitted to establish the unfavorable effect of noise on the living conditions of the residents.

Noise was mentioned by the majority of the questioned persons (82.1%, and a disturbing effect of noise - by 35.8% of the questioned persons).

Noise can be divided by the nature of its sources into street noise and noise within the block. According to our data, the disturbance from the noises originating within the block (under the conditions of winter observations) was expressed considerably less than that from the street noise.

Table 4 shows data on the residents reaction to both types of noises.

Table 4

Nature of Noise	Results of questioning residents (in %)		
	Noise mentioned	Disturbed by noise	Noise disturbs normal sleep
Street	82.1	35.8	33.9
Within the block	20	3.8	16.9

Simultaneously with questioning the residents, we measured the levels of sound pressure of the noise penetrating (with double windows) into the first floors of buildings facing the red line. The noise produced within the residential quarters under study was below 55 db. During the hours of heavy traffic in the city, its level increased up to 59-75 db.

Conclusions

1. The highest level of the sound pressure of noise was observed on the main streets which are of general importance to the city.

2. The increase in the height of buildings and the decrease in the width of the street make the noise level higher.

3. The most unfavorable condition is found in houses situated on the red line streets with heavy traffic of city transport, where the street noise disturbs the residents and interferes with their normal sleep.

THE PROBLEM OF AGING FROM A SOCIAL, HYGIENIC AND OCCUPATIONAL VIEWPOINT

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In recent years much attention has been given in medical and social economic periodic literature and in special publications in Western Europe and the USA to the problem of aging of the population. For example, according to the data published in the article "A Study on the Economic State in Europe in 1955" (Geneva, 1956) it is observed that aging of the population in Western Europe (with the exception of less developed countries in Southern Europe) is a general and stable phenomenon, and that this process progresses so uniformily that it is possible to establish certain average values for it.

The percentage of persons 65 years old or older in relation to the entire population or to the population of working age, i.e. to persons 15 to 64 years of age is accepted as an index of aging. The acceptance of a relative number of the group of 65 years and older is, evidently, determined by the fact that the retirement age for men and, with some exception for women, is established at the age of 65 in most countries of Western Europe. At the same time, in most countries of Western Europe and Scandinavia this age is now very close to the average life span of the male population.

In all countries of Western Europe, without exception, the number of persons in this age group has grown just in a five year period (1951-1956) and was, on the average, by the beginning of 1956, 16% in relation to the entire population of the working age as compared to 15% by the beginning of 1951. Since, according to many researchers engaged in the proglems of aging, the main mechanisms causing this process will be operating with approximately the same regularity in the following 15 years, by 1971 the percentage of persons of 65 years of age and older will reach, on the agerage for the

above mentioned countries of Europe and Scandinavia, 19%, fluctuating in the case of individual countries from 22% (England) to 12.5% (Finland). Thus, according to the calculations of individual researchers, the number of the age group of 65 years and older in the USA was in relation to the total number of population: In 1870 - 1,153,649 persons or 3%, in 1950 - 12,300,000 persons or 8.2%, in 1953 - 13,400,000 persons or 9%, and by 1997 it will presumably rise to 20,000,000 persons (Steinberg and Holzman).

In England in the current century, the number of population over the age of 65 or of so-called retirement age has increased from 2,250,000 persons or 6% of the entire population reaching, in 1951, 4,250,000 persons or 10%, and, presumably, if childbirth does not stop dropping, will be 8 mission or 16% in 1961. It will reach 9.5 million or 20% by 1971. Therefore, in 1961, only one child of 15 years of age or younger will fall to 1 person of retiring age, while in 1901 it was 5 children (Waldren).

The percentage of 60 year olds in the population of France increased in 1958 to 16.5 as compared to 12.4 in 1901. There were many more old women than men of the same age. In particular, there were three times more women at the age of 90 years or older than there were men. An increase in the number of old men is reported in West Germany (Klose) from 2,888,000 men, or 7.2% of the entire population, in 1939 to 4,423,873, or 9.3%, in 1950. It is also observed there that the expected life span of old people is increasing slowly but steadily, being 13.1 years for the period of 1901-1910, and 17.4 for 1949-1951.

It is quite obvious that a change in the number and the percentage in one age group leads to a change in the age structure of the population as a whole, in this particular case to a reduction of the portion in the population of other age groups. Two more age groups are singled out in the works treating the problem of aging - the group from 0 to 15 years of age and from 15 to 64, which is evaluated as the working population as a whole. Another type of grouping is used less frequently: from 0-19, 20-59, and 60 and older. If we follow the first system of age grouping, we find that the most essential shifts take place in the 0-15 age group, and, in connection with this, in the ratio between this group and the group of over 65, because the percentage of persons in the working age group changes much more slower.

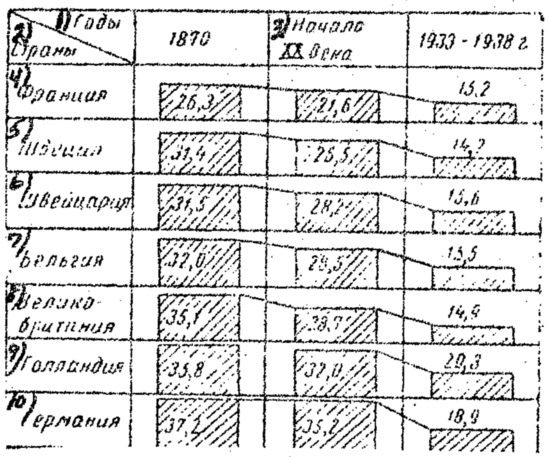
A considerable decrease in the number of people in the working age group for the period from 1939 to 1946 and only its insignificant increase for 1950-1955 is mentioned in an article by Redetzky, "Social and Hygienic Considerations Regarding the Reproduction of the Population in the

German Democratic Republic", published in the journal German Public Health (1958, No. 1, pp. 2-15). Mentioning this fact, the author writes that even now it is possible to speak of a further decrease in the number of young working people including up to 1960-1965, and only later it will be possible to expect its increase. It is mentioned in the same article that a definite predominance of male population over female up to the age of 23, which is in agreement with the normal biological correlation of sexes, is being replaced by the predominance of female population increasing with the age.

The above mentioned references to the works of various researchers from various countries make it possible to consider with a sufficient basis the aging of the adult population in the next few years as an undisputable fact. This process occurring with a definite regularity in all countries is mainly due to a decrease in childbirth (see illustration). It is caused in a much lesser degree by the reduction in the death rate and, in particular, by reduction in the death rate of persons who are 60 years of age or older. Thus, according to the data in the demography yearbook published by the United Nations Organization (New York) the increase in the expected lifespan of men for the past 40-45 years in various countries was from 14 (Norway) to 18 years (Holland), counting from the day of birth, and only from 1 year (Sweden) to 2.8 years (Holland), counting from the age of 60. Such an increase in the average life span is caused chiefly by the reduction in the child death rate, which fluctuated in the past 10 years from 5.2 (West Germany, 1951) to 1.7 (Sweden and Holland, 1957) for 100 babies born during that period.

A considerable decrease in the birthrate during the first half of the XX century, particularly during its second quarter, and its relatively low level (within the limits of 15-20 per 1000 persons) were a characteristic phenomenon for all Western Countries and partly Eastern Europe.

Among the large group of social and economic problems connected with the problem of aging, a special place is occupied by the question regarding the age when a person should terminate his active work, i.e. to stop producing material and spiritual values and stop providing for himself and his family. From this point of view, it is very important to find out and to know whether the older age group (65 years or older) will be 10% or 20% of the entire population of the working age. It is clear that the necessity of supporting this group, which will change to the state of persons of non-working age, will become an additional load for the main working group just at that period when its size will not be increasing in many countries as fast as that of the older age group.



Birth rate of the population in some countries of Europe during 1870-1938 (per 1000 persons).
Legend: 1) years, 2) countries, 3) beginning of XX century, 4) France, 5) Sweden, 6) Switzerland, 7) Belgium, 8) Great Britain, 9) Holland, 10) Germany.

One can hardly agree with Professor Brensina's viewpoint who writes in his article "The Problem of Continuing Professional Activity by Persons beyond 65 Years of Age", published in Weiner medizinishche Wochenschrift (1959, No. 2), that "only academicians can probably continue working after they have reached the age of 65".

The question regarding the pension age is connected with insufficiently favorable prospects for the renovation of the working age group. The solution of the latter in some countries, for instance in Western Germany, is reflected in the tendency toward the increase of this age in that country from 65 to 68. The reason for this, according to Klose, is the presence of about 500,000 persons or 25% among 1,992,479 people 65 years of age who still continued working in 1950. It cannot be excluded that such a reason can also be brought forward in a number of other countries where the

percentage of working people of 65 years of age is much greater than in West Germany, for example in Canada, where it reaches 39%, in the USA - 41%, in France - as high as 54%, and in Japan - 55%. It is very possible that to a certain extent for these reasons the pension age in Ireland and Norway has been established at 70 years of age (same for both men and women), and in Ireland and Sweden at 67 years of age (also the same for both men and women).

It should be noted that the problem regarding the establishment of pension age and the main characteristics of the old age pension system in different countries reflects an endeavor to encourage the productive work of the aged both from the viewpoint of increasing the overall income of the country and reducing additional expenses for their support in the form of government and non-government pensions and other forms of allowances (USA). Thus, in a number of countries (Ireland, West Germany, Switzerland, Belgium and France) pensioners are not prohibited from earning money to supplement their pensions, while in some other countries (Ireland, Norway, Sweden, Finland, Holland, Denmark, Italy and Greece) additional income is limited by a certain minimum, over which the difference between pensioner's income and this minimum is deducted from his pension.

At the same time a number of countries (Norway, Denmark, England, France and Italy) have established a yearly increase of the original amount of pension from 2 to 9.2% with a maximum increase of the pension by 40% (Norway) and even by 46% (England).

There is no doubt that many persons who reached the pension age set in each country wish to stop working. Some of them, if the situation is favorable in the labor market, they remain on the job for considerations of social-economic nature. Others try to remain on their jobs feeling that they still have preserved sufficient physical and mental activity, especially since technical progress (in particular, reductions in manual labor) and progress in medicine makes it more and more possible for older persons to remain on their jobs. However, the failing in health in persons who are beyond the pension age (most of them being 65 years of age and older, according to the data given by McConnell in his article, "Effect of the Age on Economics", published in <u>Journal of Gerontology</u>, 1957, vol. 13, No. 3, Suppl. 2, pp. 42-47, consider that the state of their health is poor) and the sharply increased tempo of production forced them to either leave their job completely or change to a different job which is more suitable for the state of their health and the still present physical and mental abilities and opportunities.

The problem of the age when a person who had been

engaged all his life in a certain professional activity has to give it up only for the consideration of age is of concern to any person who is approaching old age. Of course, the period of continuation of work to which the person is accustomed cannot be the same, varying from one occupation to another.

An attempt to answer the question of what percentage of persons who reached the age of 65 in their professional activity are physically capable to remain on the same job until the age of 70 and even later, is made by Clark and Duni in their book "Aging in Industry". The authors used the data of occupational census in England for 1951 as their initial materials. They attempted to observe, or more correctly, to establish what percentage of people remains in their original occupation and for how long after they have reached the age of 65. For this purpose they singled out 4,004,700 persons, or 25.6%, from 15,662,200 of all men working in 32 types of occupations belonging to the most important branches of industry and trades in the country. The number of persons who were 65 years of age or older was 174,000, or 25% of 695,300 of all men aged 65 and older who were working in the country.

The authors attempted to express the percentage of persons who reached the age of 65 and were physically capable to remain on their former jobs until 70 and even later for each of the 32 occupations by a roughly increased value. They called this value the survival index. In order to establish such an index, the authors used the data of the occupational census of 1931 and 1951 and noted the number of persons who reached the age of 65 after 1931. Not all, of course, reached this age remaining on their old jobs, some died during this time (20 years), and some changed their jobs. Apparently most of the persons who were shown as "unaccounted for" left their occupation before they reached the age of 65. The number of persons who died and who left their occupations before reaching 65, were not taken into consideration in calculating the above mentioned index. It was determined only on the basis of the number of persons who reached the age of 65 remaining on their previous jobs.

Apparently, a considerable number of persons reaching this age, which coincides with the pension age in England, leave their jobs, especially in the case of unfavorable situation in the labor market, and another part continues to work until an older age. In establishing a ratio of these persons, the authors did not proceed from an exactly determined age until which the work was continued (because they did not have the means to determine the number of persons who were leaving each year), but used a certain average value lying between 60 and 70 years of age. They observed the

changes which took place in the branches of industry and in the age structure of occupational-industrial groups working in them.

The author assumed that the majority of persons in the occupations under study who reached old age do not leave, however, their usual occupational jobs in order to look for another job until they are forced to do so because of the approaching old age, especially during the period of the rising in prices and the high employment. The authors considered that by using in their research two dates separated by an interval of 20 years made it possible to obtain a more balanced evaluation of the results. In this case, the survival indexes may represent enlarged percentage values of the entire number of persons who reached the age of 65 remaining on their usual jobs and are still able to perform their duties satisfactorily. At the same time, although it is not exactly known how long persons beyond the age of 65 can remain on their jobs, nevertheless, the higher the number of persons, beyond 65, the greater, on the whole, is the chance that a considerable part of them will remain on their jobs even when they reach the age of 70. In some professions a reverse situation is true, and reduction in the number of persons beyond the age of 65 progresses fast. Evidently, the ability of persons to continue their work upon reaching the age of 65 depends chiefly on the occupational activity which they are performing. There is no doubt that some types of professional activity can, more than others, have an unfavorable effect on the health of old people and cause them to stop working earlier.

As a result of their research, the authors give survival indexes in occupational cross section for persons who reached 65-70 years of age.

	Percentage of persons who reached 65-70 years of age
Watchmakers, precision processing of metal, musical instrument makers	75-85
Farmers, farm workers, foresters, forest ranger, carpenters, brick layers	65-75
Surface workmen in coal industry, welders, shoemakers, plumbers, plasterers, barge navigators, dockers, salesmen, shop owners	55-65
Underground workmen (except miners), potters, glass makers, blacksmiths,	

electroplaters, riveters, tobacco workers, cabinet makers, compositers	45-55
Smelters, paper workers, streetcar and auto drivers, conductors	35-45
Designing engineer	25-35
Coal miners, signallers	5-15

There is no doubt that changes in the hygienic conditions and the working conditions for old people in modern industry could prolong the average length of the working life in some occupations. The authors consider that a considerable number of persons would like to change their jobs when they reach the age of 60-65 so as not to be forced to leave the job completely before their time. They give a list of so-called light jobs to which elder persons change, expressing the criterium of lightness of work by the percentage of persons who are 55 years old or more in one or another occupation.

The list of these occupations is given below:

	Percentage of persons 55 years old or older
Night watchman	69
Yardkeepers	61
Apartment attendant	45
Gardeners	37
Retail clerks (tobacco, newspaper)	38
Doormen in public buildings	35
Rooming house operators	33
Furnacemen, firemen	27
Messengers	27
Butlers in homes	24

In discussing the age group of 65-70, the authors consider that at least 30-40% in this group cannot remain in their former jobs after the age of 65. These persons would like to change their occupation while they are still capable of doing some other type of work. Out of this 30% at least 2/3 must be provided with another type of work appropriate for their age if they will not be forced to stop working prematurely. The authors assumed that their research was done out of considerations to preserve a high demand for the services and an intelligent evaluation of the importance of old people in industry. A lot can still be done if the solution of this problem will be based on statistical

data. However, under the conditions of capitalism, a high demand for the services and intelligent evaluation of the importance of elderly people are not always achieved and is often accompanied by sharp crises and, as their result, by unemployment, while the socialistic regime, particularly during the transitional state to Communism, creates unlimited possibilities for maintaining a high demand for labor and, moreover, secures intelligent evaluation of the importance of elderly people. There is no doubt that during the fulfillment of a seven-year plan for the development of national economy, there will be an increase in the demand for labor, even taking into account the complex mechanization and automation of industrial processes in many branches of industry, which releases a large percentage of persons for other types of work.

We also cannot ignore the fact that also in our country, in spite of the higher level of childbirth than in the countries of Western Europe, a considerable reduction in childbirth occurred in the last quarter of the century, particularly during the war period. This factor, same as the reduction in population's death rate, including the older age groups, led to a considerable increase in the average life span and to an increase in the number and the percentage of elder persons in the general age structure of the population.

In this light, the problem of aging is of great interest to the hygienists of all occupations in our country and for public health as a great social-hygienic problem and, in particular from the occupational-industrial viewpoint. It should stress the necessity of solving such important problems as providing with rational medical aid the ever increasing number of elderly persons with their high and characteristic rate of illness (diseases of cardiovascular system, support and motor apparatus, peripheral nervous system, neoplasms, etc.), and, what is even more important the employment of elderly persons who are still capable of working to a certain degree and want to participate actively in the socialist construction. There is no doubt that the results of the population census should be used for this purpose as widely as possible, both from the social-hygienic and occupational industrial viewpoints.

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CERTAIN PROBLEMS RELATED TO THE HYGIENIC STUDY OF INDUSTRIAL NOISES

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Lately, interest in the problems of the hygienic study of industrial noises has grown noticeably. A greater range of questions connected with this problem is being included in the research topics. However, some of them are still not being sufficiently studied. The aim of this article is to attract the attention of specialists to certain urgent problems.

Thus, the methods of noise measuring should be comparatively evaluated, taking into account the broadening of hygienic problems in this field and the achievements of the measuring techniques. The recent method of recording noises on tape and than analyzing them under laboratory conditions deserved particular attention. The MEZ-29a and MAG-30 portable tape recorders are quite adequate for recording noises in the frequency range of 50 to 8000-9000 cps. Magnetic recording in many instances has great advantages over using octave filters on the spot, because industrial noises are often nonstationary in nature, and sometimes are of short duration, which makes the use of octave filters difficult. At the same time, a proper selection of tape recorders with the best frequency responses assures a sufficient degree of accuracy in measurements.

At the present time, we are faced with the problem of the necessity to broaden the frequency range of noise-analyzing instruments. There are indications in foreign publications that the presence of an ultrasonic region in the spectrum of certain industrial noises is possible (Bugard, Guennec, and Selz, 1952; Chavasse and Lehmann, 1950; Ghose, S. C., 1950; and others). Unfortunately, modern noise-measuring instruments are intended only for the frequency range of 50 to 10000 cps. Such a width of the frequency range is sufficient for a number of industrial noises because, for the majority of industrial noises, the maximum of the sound

energy in the spectrum is located in the frequency region of up to 2000-4000 cps. However, for some noises (during riveting, in aircraft construction, during certain types trimming of cast metal, etc.), a more even distribution of the sound energy in the spectrum is observed in the entire studied range, and sometimes it even rises to the region of high frequencies of 8000-10000 cps. Such a nature of the spectra indicates indirectly the possibility of the presence of a considerable sound pressure even at the frequencies of over 10000 cps, as well as the spread of sound energy to the region of still higher inaudible frequencies (ultrasounds). In such cases it is necessary to broaden the range of measured frequencies in the measuring tract up to 20000-25000 cps.

Recently, the problem regarding the peculiarities of the physiological effect of pulsed noises has been brought up (O. P. Shepelin, 1959). The number of researches in this field is very small and is not in line with a wide range of questions which arise in connection with the study of pulsed noised in their hygienic aspect. Research should be done on the development of more perfected instruments for the registration of pulsed noises with a corresponding broadening of physical parameters of noise characteristics, as well as on studying the peculiarities of the physiological effect of pulsed noises under industrial conditions and in experiments. Particularly interesting in this respect is the research by Fazanowicz (1957) who used the Kvik's method for his spectral analysis.

When this method is used, a more complex information regarding the nature of spectral components is obtained. Apart from registering the amplitudes of the sound pressure, a relative time of the continuity of particular amplitudes of sound pressure is marked for each frequency of the spectrum. The latter is demonstrated by the degree of coloration of the beam corresponding to particular frequencies. A weak coloration of the line means that the tone carries a gread acoustic pressure for a sufficiently short time; a strong coloration points to the stability of a given value of the acoustic pressure in the spectrum. In other words, weakly colored lines represent impulsive vibrations, while the strongly colored lines - uninterrupted vibrations. It is pointed out in Fazanowicz's work that indicating instruments, same as logarithmic instruments with high speed potentiometers, give average values for noises with impulses of very short duration. This average value could be very small in comparison to the instantaneous maximum pulse pressure. Such an indication should attract the attention of hygienists. It should be determined how essential are the short-term components in the spectrum in respect to their effect on the organism, and the correlation between the ear sensitivity and the sensitivity of

measuring instruments to various noises should be established.

After the introduction of Order #135 of September 7, 1957, large contingents of people working under the conditions of noise of 95 db and over must have a yearly medical checkup. Because of the great cumbrousness of the multifrequency examination of the auditory sensitivity, it is recommended in the instructions for the examination of workers subjected to the effect of noise to measure their auditory sensitivity for a limited number of frequencies (128, 4096, and 8192 cps). It is evident that in mass examinations it is expedient to reduce the scope of the examinations even more and to change to the one-frequency method of the hearing examination (4000 cps). A sufficiently large amount of material has accumulated in the past years which shows that the most expressed changes in the hearing occur at the frequency of 4000 cps or in that vicinity (Ya. S. Temkin, 1927; V. F. Undrits, 1935; B. Ye. Sheyvekhman, 1956; L. A. Kozlov, and others, 1956; P. I. Talyantsev, 1957; House, 1957; Merklin, Fox, 1957; Whitaker, 1957; Davis, Hoople, Parrack, 1958; Shone, 1958). On this basis, some of the above authors consider it expedient, in mass examinations, to confine to the measuring of hearing sensitivity at one frequency of 4000 cps. This method is convenient in that it permits to measure auditory sensitivity in usual relatively quiet premises, because it does not become masked by penetrating noises. The method does not require highly qualified personnel and is attractive because of its speed.

In the USA this method is known as the sifting method (Glorig's method). When a person's hearing is found to be lower at the frequency of 4000 cps, a further and more detailed examination may be done at a number of frequencies of air and bone conduction in a soundproof place in order to establish a more detailed picture of his hearing affection and to determine his degree of disability.

Since in most industries the auditory sensitivity of the workers becomes impaired, first of all, at the frequency of 4000 cps, it is very expedient to set up a mass production of portable audiometers for one frequency of 4000 cps, similar to the pocket-size audiometer produced in the USA (Ambco, Inc., Los Angeles).

The introduction of the one frequency method with a sufficient supply of portable audiometers for the otolaryngologists will permit in the future to make observations of the workers, particularly those who begin working in a noisy environment, more frequently. This will make it possible to single out at the proper time the persons who are particularly sensitive to the effect of noise. Thus, Shone (1958) suggested to examine the hearing of workmen in a month, and in three months after the beginning of their work in a noisy

workshop, and then to do it every six months.

It is very probable that the sifting method at the frequency of 4000 cps will not be sensitive enough with regard to those working with supersonic systems because of a special nature of the spectra when the maximum of the sound energy falls on the frequencies over 8000-10000 cps, and the auditory sensitivity will suffer first not when receiving the frequency of 4000 cps, but higher frequencies.

It is necessary to conduct further studies for the determination of symptoms which are necessary for removing workers from noisy industries. This problem requires a more precise definition. According to instruction No. 287-59 for a preventive examination of workers subjected to the effect of intensive noise transfer of workers to noiseless jobs is expedient only in the presence of expressed affection of the ear, central nervous system or cardiovascular system. Ulcers are grounds for removing a person from a noisy workshop only in the case of frequent aggravation. Such an approach to the solution of this question contradicts the very nature of the prevention of occupational diseases. Instead of revealing, for preventive purposes, the initial forms of diseases etiologically connected with the effect of noise, the instruction suggests to remove the workers from the workshop when these diseases are expressed so much that it seems more expedient not to transfer them to other workshops but to confine them to a hospital for treatment.

As yet there do not exist sufficiently clear data regarding the effect of noise on the middle ear. The question regarding the connection between diseases of the middle ear and the effect of noise on workers was raised by Ya. S. Temkin as early as in 1927. A large percentage of the diseases of the middle ear among workers in noisy industries in comparison to those working under noiseless conditions permitted him to approach the determination of occupational hearing impairment as a combined affection of the middle and the internal ear. However, sufficient attention was not given in further researches to the study of the degree of participation of the middle ear in this process, and occupational impairment of hearing is treated as a disease of the internal ear.

At the present time when preliminary examination of persons before their employment in noisy industries is becoming customary, it is possible to observe the state of the middle ear under a prolonged influence of noise. Examination of air conduction, which is compulsory according to the instruction, should be supplemented by the examination of bone conduction.

The practice of examining the working capability of persons employed in noisy industries suffers from the absence of a unified approach to the determination of the percentage

of disability. In this respect the work performed by Boenninghaus and Röser (1958) deserves attention. This work gives tables determining percentage of hearing loss depending on the distance at which normal speech and whisper are distinguished (in meters), or on the ability to make out words (in %). In order to establish the percentage of disability, binaural percentage of the hearing loss is calculated by a certain formula. It would be very useful to continue research in this field in order to establish well-founded criteria for the loss of working ability in the case of occupational impairment.

The designing of individual means of protection from noise has not, as yet, been done on a truly scientific basis. Very often no preliminary study is done on the acoustic properties of the materials and the mathematical calculation of the muffling effect. Most of the antiphones are designed by persons who do not have a sufficient knowledge of the field of physical and physiological acoustics.

At the present time, a great variety of external antiphones consisting of a multilayer combination of various materials have been developed. These antiphones are very close are very close to each other in respect to their muffling capacity. I. I. Slavin (1959) points out that the degree of muffling in earmuffs is determined by how tightly they seal the ear. In his opinion in identical muffling in different types of external antiphones is due to the fact that they seal the ear almost identically. In this connection he recommends to use the lighter cotton earmuffs which weaken high frequency sounds (over 1000 cps) by 25-30 db. It is pointed out in the Handbook of Noise Control edited by M. Harris (New York, 1957), that the best models of antiphones assure muffling by 21-25 db in the frequency region of 100-1000 cps and by 30-40 db in the frequency region of 1000-10000 cps. According to the data by T. A. Orlova (1958), some models of external antiphones produce muffling at high frequencies up to 50 db.

Because of the use, in recent years, of comparatively soft materials for ear plugs (plastic materials of hollow rubber caps put on a hard peg) they evidently will be more widely used among other protective measures from noise because of their comparatively simple and convenient use. In this muffling effect, some of them are as good as the external antiphones.

Further attempts to increase the muffling effect of individual protection devices from noise, in spite of the limitations of this effect, cannot be considered completely fruitless. The testing of various new synthetic materials may open some possibilities in this respect. For example, cotton make of ultra thin glass fiber (from 1 to 3μ in

diameter) absorbs sound to a much greater degree than ordinary cotton. Cotton of ultra thin glass fiber is soft and elastic and it can be used for the protection from noise in the form of compact lumps inserted into the external auditory meatus. The muffling effect in this case is the same as in the case of ear plugs of the Czech model (rubber cap put on a plastic peg). Such cotton is widely used for protecting workers from noise in industrial enterprises of Finland.

At the present time it is difficult to give a comparative evaluation of various means of individual protection because antiphones are not yet widely used in the Soviet Union and it is difficult to evaluate the convenience of wearing antiphones without a long term study under industrial conditions. The problem of the means of individual protection requires further examination. It is necessary to continue efforts in developing antiphones in which the best muffling capacity would be combined with the greatest convenience and simplicity of their use. The participation of otolarynfologists was completely insufficient in the study of this problem. At the same time, combined observations by hygienists and otolaryngologists on a prolonged use of antiphones under industrial conditions would be very useful.

Evidently different designs of antiphones will be suitable for different industries depending on the conditions of industrial environment (dust, microclimate, etc.).

From the editors. This article brings up some controversial questions. The limitation in determining auditory sensitivity only for the frequency of 4000 cps is not shared by many hygienists and preventive pathologists. Although it is true that the total threshold changes, first of all and most of all, at the frequency of 4000 cps, this cannot serve as an argument to exclude the determination of auditory sensitivity at other frequencies. It is expedient to apply speech audiometry, which is not pointed out by the author. His formulation of the question of determining the percentage of disability can hardly be based scientifically, particularly on the material by Boenninghaus and Röser. The approach to the determination of the degree of disability by the percentage of the hearing loss is incorrect. Apart from the means of individual protection of hearing the most important is a collective protection, which the author does not mention at all. Individual protection is only a palliative to which we have to resort only in exceptional cases. We also cannot agree with his statement regarding the advantage of using plugs against external antiphones. Publishing this article, the editors request the readers of this journal to express their opinion on the problems raised in the article, especially since the last regulation on the measures for the abatement of noise in industry requires an increased attention to them.

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STANDARDIZATION OF AUTOMOBILE TRAFFIC NOISE

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The main source of outside noise creating a constant noise background in the city and in residential buildings in the city transport traffic. The analysis of the measurements of city traffic noise conducted during the past decade shows that its level is constantly growing. The noise from street traffic penetrates into the apartments of residential buildings, reaching in some instances 70-80 db and causing frequent complaints from resident.

Protection of residences from street noise may be achieved by certain measures of planning and technical nature. However, a radical measure for reducing the noise from street traffic is the reduction of noise produced by motor vehicles. Numerous studies conducted here and abroad show that this task can be successfully accomplished.

There is no doubt that the means spent on this will be fully compensated by the improvement of the sanitary conditions of life, work and rest for the population in big cities. The first and foremost measures for traffic noise control should be the development of unified measuring methods and standards for permissible values of noise produced by the individual types of vehicles.

Until recently, insufficient attention was given in the Soviet Union to the problems of controlling the noise produced by motor vehicles. The absence of a unified method for measuring such noise does not permit to make appropriate conclusions for the individual results of the tests. When new automobiles are put on the market, their noise characteristics are not given, although the noise reaches a considerable value.

Table 1 shows the data on the noise from different types of city vehicles when they are moving in high gear.

The distance from the line of traffic to the measuring microphone was 6-10 meters.

Table 1
Noise Levels from Various Types of Motor Vehicles.

Type of Vehicle	Average sound pressure level (in decibels)
Trucks with gasoline engines	90
Trucks with diesel engines	95
Passenger automobiles	76
Buses	85
Motorcycles	86

Much more attention is given abroad to the problems of traffic noise control. Most of the countries have appropriate codes which limit the maximum permissible noise values of motor vehicles. Nevertheless, the conditions and methods of measuring the value of traffic noise differ substantially in foreign countries. Table 2 summarizes the maximum permissible standards of traffic noise adopted in different countries.

In most of the countries, the maximum permissible values are established at the levels measured by the noise gauge by means of the correction curve of frequency response B (or in some types of noise gauges - 70 phons). It is customary, only in Sweden, to take measurements on the correction curve A of the frequency response of the noise gauge. The use of the frequency response correction curves of the noise gauge is explained by the fact that they permit to calculate to a certain degree the perception of noise by the human ear.

On the basis of foreign data, studies done by a number of research institutes, and recommendations of the International Organization on Standards, the working group of the Committee for Noise Control at the Main Public Health Inspection of the Ministry of Public Health, USSR, worked out a draft of the Provisional Standards for a permissible value of noise produced by motor vehicles.

The draft of the standards was worked out, on the one hand, with a consideration of noise from automobiles produced by our industry, and, on the other hand, with the consideration of the necessity to reduce this noise to acceptable values both for sanitary and hygienic reasons, and with the consideration of the permissible automobile noise as stated in the foreign standards. Moreover, the draft of standards was compiled in agreement with the recommendations on the testing methods for vehicles by the International Organization on Standards.

Table 2

The Maximum Permissible Standards for Motor Vehicle Noise in Different Countries.

1) Страна	2) Единица измерения	3) Предельно допустимые величины шума: 4) велосипед с мотором	5) мотоциклы	6) легковые автомобили	7) Грузовые автомобили: 8) с бензиновым двигателем	9) с дизельным двигателем	10) автобусы	11) Условия для транспортной единицы: 12) стоящий транспорт	13) движущийся транспорт
14) Финляндия	15) Децибел В	75	82—84	85	90	90	90	16) Работа двигателя при максимальной нагрузке с числом оборотов, соответствующим скорости 40 км/час	
17) Франция	»	78 30	85 60	85 60	88—95 80—90	88—95 80—90	88—95 80—90	—	18) Движение по неровному шоссе со скоростью (км/час)
19) Люксембург	»	75	80—85					20) Работа двигателя при максимальном числе оборотов	
21) ФРГ	»	75	80—82	82	22) Грузоподъемность до 2 т—82 Выше 2 т—87	87	87	Работа двигателя на ре- 23) жиме, соответствующем максимальной скорости	24) Движение при полном газе. Скорость при помощи торможения—50 км/час
25a) Англия	»		80—85					26) То же	
25b) Швеция	»	80	85	80	88	88	88	» »	27) Движение при полном газе. Скорость при помощи торможения—40 км/час
28a) Швеция	»	75—80	80—85—90	80	85	90	85	» »	—
28b) Чехословакия	»				85	85	85	—	29) Нормальная скорость, полная нагрузка двигателя

[For Legend, see page 90]

Table 2 (see page 89)

The Maximum Permissible Standards for Motor Vehicle Noise in Different Countries.

Legend: 1) Country, 2) Unit of measurement, 3) Maximum permissible noise values, 4) Bicycle with a motor, 5) Motorcycles, 6) Automobiles, 7) Trucks, 8) With gasoline engine, 9) With diesel engine, 10) Buses, 11) Conditions for the vehicle, 12) Standing vehicles, 13) Moving vehicles, 14) Finland, 15) Decibel B, 16) Engine running at maximum acceleration with number of revolutions corresponding to the speed of 40 km/hour, 17) France, 18), Moving on uneven road at the speed of (km/hour), 19) Luxemburg, 20) Engine running at maximum number of revolutions, 21) German Federal Republic, 22) Load capacity up to 2 tons - 82; over 2t - 87, 23) Engine running at the rate corresponding to maximum speed, 24) Moving at full acceleration. Throttled down speed - 50 km/hour. 25a) England, 25b) Sweden, 26) Same as 23), 27) Moving at full acceleration. Throttled down speed - 40 km/hour, 28a) Sweden, 28b) Czechoslovakia, 29) Normal speed, full acceleration of engine.

The draft of standards set forth the requirements only for moving vehicles, because this is the most important characteristics determining the noise from vehicles in cities. The developed method and measuring conditions permit to compare the noise from our vehicles with that of other countries.

In a very near future, control measurements for the types of vehicles enumerated in Par. 4 of the Standards will be conducted, which will permit to make final corrections of the maximum permissible values of their noise. We are giving below this Draft.

Draft

Provisional Standards for the Permissible Value of Noise from Motor vehicles.

I. Purpose and Sphere of Application.

Par. 1. The present standards affect the means of road transport produced by industry.

Par. 2. The means of road transport are: trucks, passenger cars, buses, motorcycles, motor-scooters, and bicycles with gasoline motors.

Par. 3. The present standards affect vehicles in operation from 196..

II. Permissible Noise Values.

Par. 4. The noise produced by transport units should not exceed the values given in Table 1.

Table 1

Type of Vehicle	Noise level measured by a noise gauge at the frequency response B of the noise gauge (in decibels) [See Note]
Bicycle with a motor	75
Passenger car	80
Motorcycle, motor scooter	83
Bus	85
Truck with gasoline engine	85
Truck with diesel engine	90
Other types of motor vehicles	90

[Note] Figures in Table 1 should be considered only as tentative, which should be rendered more exact after the control measurements of the noise from the vehicles enumerated in the Table.

III. The Measuring Method for Vehicles.

Par. 5. Conditions for measurements.

The measuring microphone should be installed 1.25 m above the ground and turned in the direction of the moving vehicle. The distance between the microphone and the longitudinal axis of the vehicle should be 7.5 m. The vehicle should be moving along a level section of an asphalt road which is dry and not covered with anything (e.g. with snow). Measurements are taken on both sides of the moving vehicle at the moment of its passing the line between the microphones (observation line).

Within the radium of 20m from the microphone, there should be no object (houses, trees or embankments) which would reflect sound. There should be no people between the object of the measurements and the measuring microphone. The level of noise disturbances should be 10 db lower than the measurement results.

Par. 6. Conditions of the Vehicle's Operation.

The vehicle (without a load or passengers) moves to the line situated 10 m from the observation line at the speed which is standard for that type of vehicle and being in gear. At the time of crossing this line, the throttle is quickly opened completely and it remains in this position until the vehicle crosses the line situated 5 m away from the observation line. Then the throttle is quickly shut.

The data on the standard speeds are given in Table 2.

Table 2

Type of vehicle	Size of cylinders (in cm^2)	Speed (in km/hour)
Motorcycles, motor scooters, and bicycles with a motor	up to 50	30
	50-125	40
	125	60
Passenger cars, trucks of up to 1.5 t load capacity, and buses with not more than 8 seats for passengers	-	60
Trucks and buses	-	40

V. Requirements for Measuring Instruments.

Par. 8. Measurements may be done with a noise gauge or other measuring instruments having the frequency response correction B and corresponding to the recommendations for the noise gauge specifications of the International Electrotechnical Committee (MEK TK-29 29/IB/32).

Measuring instruments should be regularly (not less than once a year) checked and approved by the organs of the Committee on Standards of Measures and Measuring Instruments.

VI. Responsibility for Fulfilling Standards.

Par. 9. Plants are responsible for the control of the noise characteristics of the new vehicles manufactured by them. Noise control of vehicles now in use is accomplished by the organs of the ORUD.

It should be mentioned in conclusion that it is necessary to conduct extensive research on the development of measures for reducing the noise of motor vehicles, and, consequently, to make the requirements for its abatement more rigid.

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HYGIENIC CHARACTERISTICS OF NOISE AT SUGAR REFINERIES

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Until the present time in studying working conditions at sugar refineries the attention of researchers was concentrated on the effects of microclimatic factors. In the meantime, while studying the problems of labor hygiene at sugar regineries, we notices that in many workshops a noise of considerable intensity is present, being of a constant nature throughout a shift. Frequently sugar refinery workers complained of noise in the ears after work. This was the basis for studying the present problem. The noise intensity was measured at the places of work at the ear level of the workers by means of ShI-1 noise gauge. A total of more than 500 noise measurements has been taken. The hearing of the workers was examined by Otolaryngologist E. A. Matsievskaya. In most sugar refineries the entire technological process of refining sugar is done in the main building of the refinery where the main workshops are usually located: Beet processing, juice-refining, production, and repair and power workshops. Only the boiler room, the lime department and the packing department are located separately.

The main sources of noise at sugar refineries are: piston, centrifugal, pinion and rotary pumps with various driving gears which are usually installed on the first floors of the main refinery halls; the movement of liquid, air and steam under pressure of vacuum along the pipelines connecting the apparatus and mechanical equipment used in refining sugar and located most frequently on platforms of the second and third floors in the main halls; clanking and scraping from beet and sugar elevators, rake and screw conveyers; centrifugal or disk beet cutters installed on the second floor platforms in the main building; air-condensing system situated in the zone of vacuum aparatus and the 4th evaporation chamber, the steaming process of the vacuum apparatus and the centrifugal machine; fans and exhaust fans in the boiler rooms, etc.

Thus, noise at sugar refineries is basically of a

hydroaerodynamic origin and is characterized by medium and high-frequency vibrations, which determines to a considerable degree its harmful effect on human organism (N. I. Slavin). We did not have an opportunity to study the frequency responses of the noise because of the absence of a noise analyser.

Not less than 10-15 noise measurements were taken at each working place.

According to the obtained data, the noise level at sugar refineries (in general) fluctuates within the limits of 85-95 db with a predominance of 85 db. The highest noise intensity is in the repair and power shop, in the washing department, during the cutting of beets, and in the supply department of the heating and power station, where the noise level reaches approximately 90-105 db. (Table 1) [see pages 95 and 96 for table]

Our study of the workers' hearing organs coincided completely with the data on the intensity of noise in factory workshops. Thus, hardness of hearing was revealed in workers of the repair and power shop (14%), where the highest noise intensity is present - 85-98 db, then among the workers of the beet-processing shop (12%), where noise intensity is 82-95 db, and also in the boiler room (11%) with the noise intensity of 82-95 db. The occurrence rate of hearing impairment was in a direct connection with the length of employment. Among the workers of a three year employment, hearing impairment is observed 33 times less frequently, and in the case of 5-10 year employment - 4 times less frequently than in workers who were employed for more than 10 years.

If we take into consideration that, according to Ya. S. Temkin, hearing impairment of the entire population is 2-3%, then in the workers of the sugar refineries hearing impairment occurs approximately 3-4 times more frequently.

All this convinces us that the noise factor at the sugar refineries is one of the important occupational unhealthy conditions.

The study of the influence of noise on sugar refinery workers is of particular interest inasmuch as, unlike other branches of industry, sugar refineries operate only 4-6 months in a year, after which an overhaul of the equipment is done. During this time the workers are engaged in repair or agriculture work and are not subjected to the effect of noise. The observed changes in the hearing organs of the workers are stable in nature because they took place at the beginning of the manufacturing process.

It is noticeable that with the introduction of more advanced equipment, as well as with mechanization and automation of technological processes in sugar refining, the noise intensity in the refinery workshops often increases. This is

Таблица 1

1) **Интенсивность шума в цехах свеклосахарных заводов (в децибелах)**

2) Место замера	3) Источник шума	4) Наркевичский сахарный завод Хмельницкой области	5) Турбовский сахарный завод до реконструкции Винницкой области	6) Каменогорский сахарный завод Винницкой области	7) Ситковецкий сахарный завод Винницкой области
8) Моечное отделение	9) Свекловичные элеваторы, шнеки, по которым передвигается свекла, моечные машины	90—95	82—90	90—95	82—85
10) Автоматические весы и свеклорезки	11) Автоматическое переключение весов, падающая свекла в свеклорезки; свеклорезки (изрезывание свеклы)	90—97	92—98	90—90	90—95
12) Диффузионная станция	13) Открывание и закрывание крышек диффузоров, лязг цепей транспортера и работающие насосы в общезаводском зале первого этажа	85—85	82—85	80—85	80—85
14) Станция дефекосатурации	15) То же. Проходящие по трубопроводам жидкость, пар и сатурационный газ	82—85	82—85	80—85	82—85
16) Фильтрпрессная станция	17) То же и удары сдвигаемых рам	85—85 18) вакуум-фильтры	82—85	80—85	82—85
19) Выпарная станция	20) Прохождение пара и жидкости по трубам	85—85	80—85	80—85	80—85
21) Варочно-кристаллизационная станция	22) То же	82—85	82—85	80—85	82—85
23) Пробелочное отделение	24) Двигатели приводов центрифуг и ременные передачи	85—95	82—90	85—93	82—85
25) Сушка сахара	26) Электродвигатели (нагнетание теплого воздуха в барабан), вращение барабана	85—95	82—85	85—85	80—85
27) Ремонтно-силовое отделение	28) Поршневые, плунжерные, центробежные и другие насосы (17—30 штук)	95—97	95—98	85—95	85—95
29) Котельная (с топкой углем)	30) Работающие воздуходувки и дымососы	85—95	82—84	82—85	82—85
31) Питательная станция ТЭЦ	32) Насосы, подающие воду в котлы	97—105	—	—	—

Table 1

Legend: 1) Noise intensity in the shops of beet sugar refineries (in decibels). 2) Place of measurement. 3) Source of noise. 4) Narkevichi Refinery, Khmelnitskaya Oblast. 5) Turbov Refinery before reconstruction, Vinnitskaya Oblast. 6) Sitkovetskii Refinery, Vinnitskaya Oblast. 8) Washing Department. 9) Beet elevators, screw conveyors and washing machines. 10) Automatic scales and beet cutters. 11) Automatic shifting of scales, falling beets in the cutter, and beet cutter. 12) Diffusion station. 13) Opening and closing of the lids on the diffusers, clanking of the chains in the conveyor and working pumps in the main hall on the first floor. 14) Defecation and carbonation station. 15) Same as 13). Liquid steam and carbonation gas passing through the pipelines. 16) Filtering and pressing station. 17) Same as 15), clashing of frames. 18) Vacuum filters. 19) Evaporation station. 20) Passing of steam and liquid through the pipes. 21) Boiling and crystallizing station. 22) Same as 20). 23) Bleaching department. 24) Motors of centrifuges and driving belts. 25) Drying of sugar. 26) Electric motors (pumping warm air into a drum), the turning of the drum. 27) Maintenance and power department. 28) Piston, plunger, centrifugal and other pumps (17-30 items). 29) Boiler room (coal furnace). 30) Blowers and exhaust fans. 31) Feeding department of heating and power station. 32) Pumps supplying water to boilers.

partly proved by the data in Table 1. They show that in some departments (washing, repair and power, and others) at the refineries with a better technical equipment and which are completely electrified, (Narkevichi and Turbov) we observe noise of greater intensity than at old refineries (Kamenogorsk and Sitkovetskii) which are still working with steam engines.

The above is more clearly confirmed by the data given in Table 2 which indicate sharp increase in the noise intensity at the Turbov Sugar Refinery after the introduction of new advanced equipment. For example, in 1958, the following machines were installed at the Turbov Sugar Refinery: Diffuser of continuous action, vacuum filters, new washing machine, and a part of a semiautomatic centrifugal machines, the use of which makes the work considerably easier, improves working conditions and considerably reduces the cost of production. However, the noise level at all working places in the main hall increased to 90-110 db. The increase in the noise level was connected with the errors in the installation of the RMK air pumps which are a part of the vacuum filters. Moreover, a change of the steam boilers to liquid fuel, apart from sharply improving the health conditions and a greater economy resulted in the appearance of a high frequency noise produced

by the steam dispersion of fuel oil by the spray burners. The noise intensity in such cases is 90-105 db (see Table 2) or more, so that some workers even complained of pain sensations. We often observed in this case that the workers protected themselves from the unpleasant effect of noise by putting cotton in their ears.

Table 2

Таблица 2

1) Интенсивность шума на Турбовском сахарном заводе

3) Место замера	2) Интенсивность шума (в децибелах) 4) 1957 г. до реконструкции завода	5) 1958 г. после реконструкции завода	1959 г. после проведения мероприятий по снижению шума 6)	7) Примечание
8) Моечное отделение	82—90	95—100	85—92	9) В 1958 г установлена новая моечная машина
10) Автоматические весы и свеклорезка	92—98	95—105	95—97	
11) Станция дефекосатурации	82—85	90—95	80—85	
12) Фильтрпрессная станция	82—85	95—100	85—90	13) В 1958 г. установлены вакуум-фильтры вместо фильтр-прессов
14) Выпарная станция	80—85	90—95	82—85	
15) Варочно-кристаллизационная станция	82—85	90—93	85—85	
16) Пробелочное отделение	82—90	95—98	85—90	
17) Сушка сахара	82—85	82—85	80—84	
18) Ремонтно-силовой цех	95—98	95—110	88—95	
19) Котельная	82—84	82—85	90—100	20) Котлы переведены на жидкое топливо в 1959 г.
21) Котельная Каменогорского сахарного завода	—	85—85	95—105	22) То же

Legend: 1) Noise intensity at the Turbov Sugar Refinery. 2) Noise Intensity (in decibels). 3) Place of Measurement. 4) 1957 before reconstruction of refinery. 5) 1958 after reconstruction of refinery. 6) 1959 after taking measurements for noise abatement. 7) Remarks. 8) Washing department.

9) New washing machine installed in 1958. 10) Automatic scales and beet cutter. 11) Defecation and carbonation station. 12) Filtering and pressing station. 13) Vacuum filters installed instead of filter presses in 1958. 14) Evaporation station. 15) Boiling and crystallizing station. 16) Bleaching department. 17) Drying of sugar. 18) Maintenance and power shop. 19) Boiler room. 20) Boilers changed to liquid fuel in 1959. 21) Boiler room of the Kamenogorsk Sugar Refinery. 22) Same as 20).

After our remarks and suggestions, the administration of the Turbov Sugar Refinery took measures for reducing the industrial noise. They removed the installation defect of the RMK pumps and installed mufflers at the exhaust of the pumps having a funnel shape and routed them out of the building. As a result of this, measurements taken in 1958 indicated that the noise intensity at the working places in the mail hall reduced from 90-110 db to approximately 85-90 db (see Table 2). Although this reduction was not great, it shows, however, that it is possible to control such a harmful factor as noise in industry.

At the present time spray burners in the boiler rooms are being replaced very slowly with the noiseless ones, in which the oil is sprayed mechanically and which considerably lowers the effect of noise.

Thus, the public health officers and designing engineers creating new equipment for sugar industry, and special designing organizations are not yet concerned with everyday noise control at sugar refineries.

Conclusions

1. At modern beet sugar refineries, one of the most important occupational detriments to health is industrial noise, whose level is, on the average, within the limits of 85-95 db, and in individual cases even higher - up to 110 db. The noise is characterized by medium and high-frequency vibrations.

2. The rate of hearing impairment in the workers at sugar refineries is directly connected with the noise intensity in the industrial environment. The hardness of hearing increases with the length of employment.

3. Until now proper noise control has not been practiced in sugar industry, therefore, noise is increasing at many refineries, this being often connected with the introduction of new equipment.

4. It should be considered that radical means of industrial noise control of sugar refineries is the soundproofing of the equipment. For this purpose it is also necessary to supervise the mechanical condition, the proper installation,

and a thorough assembling of the parts of pumps, motors, fans, and other mechanical systems.

5. A change to liquid fuel should be considered as a very important and advisable hygienic measure for the boiler rooms of sugar refineries. However, it is necessary to have a mechanical and not the steam spraying of the fuel oil, which permits to reduce sharply or even completely eleminate the noise.

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NOISE CONTROL ON THE RAILROADS

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Out of all types of transport - railroad, automobile, water, and air - the noise of railroads is most widespread and is affecting a great number of people not only those employed in railroad transportation but also those who live near railroads.

The most widespread noises are those produced by the operation of marshalling yards and the noises accompanying the movement of trains. The control of these noises is also important because, with an unprecedented growth of housing construction, railroad tracks and stations have now become included in the city limits. Railroad stations are surrounded by hundreds of tracks and auxiliary enterprises situated in cities. Railroads are engaged in a further mechanization of the rebuilding processes for their cars, are introducing new types of traction, and are increasing the speed and the traffic of their trains. Table 1 shows the levels of intensive noise sources at a mechanised marshalling yard.

The noisiest areas are the areas of the hill, and the compressor and the brake positions in the sorting yard. The most intensive noises are sudden interrupted noises from: locomotive signals, escape of air from the brake cylinders, scavenging of locomotives, the clashing of automatic couplers of cars in the sorting yard, screeching on the curves during the pulling of cars from the sorting yard to the hump, the system of loudspeakers, noises from the compressors and the tractor pushing cars in the sorting yard day and night. The amount of noises is very high. In one hour, there are hundreds of locomotive whistles and hundreds of instances of air escape from the brake cylinders of the retarders. For 20-25 minutes during an hour, orders are given through a loudspeakers, and hundreds of instances of the braking (screeching) of cars take place on the brake shoes.

The noise from these sources affects not only those who work in these areas (marshalers, couplers, brake shoe operatore, etc.), but also people working in the building

Table 1

Levels of Noise from Various Sources at a Mechanized Marshalling Yard.

1) Источник шума	2) Расстояние от источника (в м)	3) Уровни шума (в дб)	4) Характеристика шума
5) Паровой свисток локомотива	5	115—125	17) Высокочастотный
6) Воздушный » »	5	87—112	Средний и высокочастотный 18)
7) Выхлоп воздуха из тормозных цилиндров замедлителей М-50 и КВ-4 . . .	1	110—127	19) Высокочастотный
8) Торможение вагонов на тормозных башмаках	5—15	90—115	»
9) Продувка паровозов	10	110	»
10) Трактор, осаживающий вагоны в подгорочном парке	2—4	85—95	—
11) Удары автосцепок вагонов в подгорочном парке	15—20	86—100	—
12) Вытаскивание вагонов из подгорочного парка на горку (визг на кривых) . .	5	85—103	—
13) Очистка замедлителя сжатым воздухом	1	105—110	20) Высокочастотный
14) Шум при всасывании воздуха компрессорами: 200 В-10/8	1	112	—
160 В-20/8		105	—
15) Громкоговорящая связь в парках . .	10—15	75—80	—
16) Наружный шум тепловозного двигателя при маневровой работе (ТЭМ-1, ТГМ-1, ТЭ-1)	1	86—105	—

Legend: 1) Source of noise; 2) Distance from the source; 3) Noise levels (in db); 4) Noise characteristics; 5) Steam whistle of the locomotive; 6) Air whistle of the locomotive; 7) Air exhaust from the brake cylinders of the M-50 and KB-4 retarders; 8) Retardation of cars on the brake shoes; 9) Scavenging of locomotives; 10) Tractor shunting cars at the hump yard; 11) The clashing of the automatic couplers of cars at the hump yard; 12) The pulling of the cars from the hump yard to the hump (screeching on the turns); 13) Clearing the retarder with compressed air; 14) Noise from the suction of air by the compressors: 20 B-10/8
160 B-20/8
15) System of loudspeakers in the yards; 16) External noise of the diesel locomotive during the shunting (TEM-1, TGM-1, TE-1); 17) High-frequency; 18) Medium and high-frequency; 19) High-frequency; 20) High-frequency.

Note. Measurements were taken with the Sh-3 sound gauge and ASh-2 LIOT analyser.

situated near the hump, as well as the residents in the vicinity of the yard. Moreover, the excessive noise interferes with the perception of the sound signals and orders transmitted through the loudspeakers.

Measurements have shown that the noise levels penetrating into the regulating and control stations are 65-87 db. In accordance with the noise abatement standards in industry [See Note 1] and the sanitation standards for designing industrial buildings [See Note 2] the standard of 50 phons or 60 db has been established for low-frequency noise. The same standard should also be accepted for the buildings at marshalling yards. A reduction of noise levels by 7-15 db in the rooms of the regulating and control stations can be achieved by soundproofing the windows, by installing double windows, and by placing rubber stripping on the window glass. An additional reduction of noise by 6-8 db may be achieved by covering the walls and the ceiling with sound-absorbing materials [See Note 3].

[Note 1] Provisional Public Health Standards and Rules for Reducing noise in Industry, No. 205-56, M, 1956.

[Note 2] Public Health Standards for Designing Industrial Buildings, N 101-54, M, 1958.

[Note 3] Instructions for Reducing Industrial Noises in Industrial Buildings and Structures. LIOT, L, 1959 (draft).

As it has already been mentioned, the noise from marshalling yards disturbs residents near them and causes numerous complaints from the workers. At the suggestion of the Leningrad City Executive Committee, the Department of Industrial Safety Measures of the Leningrad Institute for Railroad Engineers conducted measurements of noise levels in the apartments of buildings situated near a mechanized hump yard (Illustration 1). The results of these measurements are given in Table 2. As it can be seen from the results, the noise loudness levels penetrating into the apartments exceed in all cases the permissible level of 35 phons. Living conditions near the marshalling yards are particularly unfavorable during the summer when the windows are open.

It may be recommended to move marshalling yards out of city limits. But this would cost tens of millions of rubles and could hardly be accomplished in the near future. Therefore, measures should be taken at present to reduce the intensity of the noise sources.

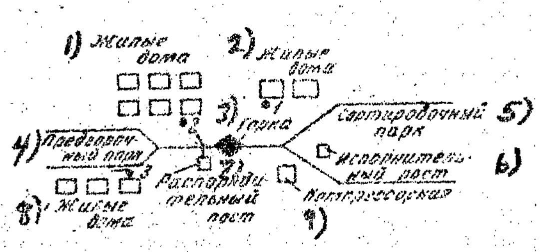

Illustration 1. Location of points of measuring the noise loudness levels at the marshalling yard.
Legend: 1) Residential buildings; 2) Residential buildings; 3) hump; 4) Hump shunting yard; 5) Sorting yard; 6) Control station; 7) Regulating station; 8) Residential buildings; 9) Compressor station.

According to an order of the Ministry of Communications, USSR, locomotives in big cities and resort areas are outfitted with additional less loud whistles in order to reduce the noise from their signals. The locomotive crews must use the additional less loud signals when they are in the area of big cities or resort places, except such instances when there is a danger to the lives of people, or a possibility of obstacles and it is necessary to give a danger signal. According to the measurements, the loudness level of the less loud signals in the area of the station Leningrad-Moscow Marshalling Yard (at the distance of 5 m from the locomotive) is 80-120 db, and at the Kishinev Depot - 87-112 db (Table 3 gives loudness levels of the signals of 10 locomotives at the Kishinev Depot).

Thus, many of the less loud signals are excessively loud and sharp in their timbre and differ very little from the loud whistles. In order to reduce the noise from the whistles of the locomotives to limit the intensity of the less loud signals to 90 db at the distance of 5 m from the locomotive. The method of giving loud and not as loud signals stipulated in the order of the Ministry of Communications, USSR, for big cities and resort areas should be reflected in the instruction of signalling and include all cities and other populated areas.

Table 2

Noise Levels in the Apartments Situated Near a Mechanized Hump.

1) Источник шума	2) Уровни громкости шума, проникающего в квартиры (в фонах)			
	3) точка 1. 50 м от горки; 5-й этаж, одинарное остекление, форточка закрыта	4) точка 2. 80 м от горки; 2-й этаж, одинарное остекление, форточка закрыта	5) точка 3. 200 м от горки; 2-й этаж, одинарное остекление, форточка открыта	6) точка 4. 300 м от горки; 5-й этаж, двойное остекление, форточка открыта
7) Сигналы локомотивов	47—57	45—62	45—63	39—57
8) Выхлоп воздуха из тормозных цилиндров замедлителей	43—60	43—55	40—53	41—47
9) Всасывание воздуха компрессорами	50—51	44—50	49—52	35—42
10) Торможение вагонов на тормозных башмаках	55—67	47—51	—	41—55
11) Продувка паровозов	45—48	50—58	51—57	41—44
12) Громкоговорящая связь	48	35—41	45—48	40—42
13) Визг на кривых при вытаскивании вагонов из сортировочного парка на горку	47—52	47—52	—	40—43
14) Проход автомашин	56—68	60—70	64—67	42—50

Legend: 1) Source of noise; 2) Loudness levels of noise penetrating into the apartments (in phons); 3) a point 1.50 m away from the hump, 5th floor, single window, ventilation pane closed; 4) a point 2.80 m away from the hump, 2nd floor, single window, ventilation pane closed; 5) a point 3.200 m away from the hump, single window, ventilation pane open; 6) a point 4.300 m away from the hump, 5th floor, double window, ventilation pane open; 7) signals of the locomotives; 8) air exhaust from the brake cyclinders of the retarders; 9) suction of air by the compressors; 10) retardation of cars on the brake shoes; 11) scavenging of locomotives; 12) system of loudspeakers; 13) screeching on the turns when pulling the cars from the sorting yard up the hump; 14) passing of motor vehicles.

Table 3

Loudness levels of signals of various locomotives.

1) № паровоза	2) Уровень громкости сигналов (в фонах)		5) № паровоза	6) Уровень громкости сигналов (в фонах)	
	3) малого (воздушный)	4) большого (паровой)		7) малого (воздушный)	8) большого (паровой)
9) Эр-773-07	90	125	Эу-686-90	87	115
Эр-794-15	90	120	11) ТЛ-1514	99	117
Эр-795-66	110	122	ТЛ-2305	112	120
Эр-795-76	110	115	ТЛ-1515	92	120
10) Эу-682-47	98	120	ТЛ-2506	110	120

Legend: 1) Number of locomotive; 2) Loudness level of signals (in phons); 3) Small (air); 4) Large (steam); 5) Number of locomotive; 6) Loudness levels of signals (in phons); 7) Small (air); 8) Large (steam); 9) Er; 10) Eu; 11) TL.

The noise from the escape of exhaust air from the cylinders of the retarders at the operating humps can be reduced by installing mufflers on the exhaust pipes. In designing new retarders, it is expedient to replace the electropneumatic drive of the retarder with an electromechanical, which is even simpler and cheaper to install and operate. Only electromagnetic retarders can be almost noiseless. The noise from the suction of air by compressors can be reduced by installing intake mufflers. The replacement of the compressor 200 in 10/8 with a more productive 160 in 20/8 will reduce the noise of air suction by 7 db, and besides will reduce the time of the operation. The noise on the turns and the wearing out of the tracks and wheels can be reduced by installing special devices at the curved sections of the tracks.

The installation of the retarders in the marshalling yard which is in progress now will permit to give up the use of brake shoes, will relieve a considerable number of break shoe operators and will reduce the transmission of orders through the loudspeakers. At the stations where brake shoes are still being used, the sudden breaking and the noise produced by the friction of the shoe base against the rail head can be reduced by using a self lubricating shoe.

The noise of the tractor which pushes the cars in the marshalling yard can be reduced by installing an additional muffler at the escape of the exhaust gas and by covering the hood of the tractor with a sound-absorbing material. The mechanical noises of the retarders can be reduced by removing excess gaps, by balancing the moving parts, good maintenance of the tracks under the retarder by replacing the metal parts hitting each other with plastic parts, by putting a rubber lining between the foot of the rail and the frame of the retarder and by other measures. The reduction of noise from powerful sources will permit to reduce the power of the reproducers and will improve the audibility of signals and commands at the yard.

A considerable noise is created by trains moving at high speeds. Illustration 2 shows the dependence of noise levels on the speed of movement of locomotives, and passenger and freight trains. The intensive noise created by moving trains affects not only the service personnel and passengers (a considerable amount of studies have been done in our country and abroad on this subject - A. M. Volkov, D. Zboralskii, and others), but also the residents who live near the railroad. The effect of noise from moving trains on the people living near the railroad tracks has not yet been sufficiently studied, but some authors point out the effect of this noise on the organism. For example, F. Ingerslev points out that the blood pressure of a sleeping person increases under the influence of the noise from train passing near his open windows. And noise created by trains is heard far in the surrounding areas.

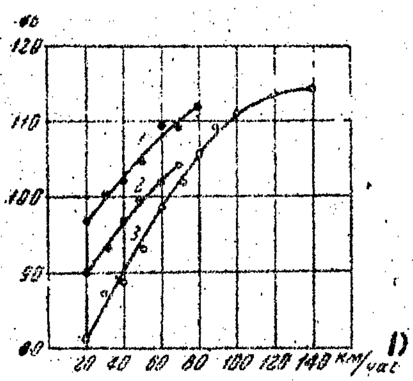

Illustration 2. Dependence of average levels of external noise on the speed of movement.

1 - Lovomotives of the TL and Er series; 2 - Box cars and gondola cars of freight trains; 3 - Passenger trains of all-metal cars.
Legend: km/hour.

In order to describe the spreading of such noise, let us take two most characteristic instances.

In the first case a three-story brick house was situated near the approach to the station at a distance of 30-35 m from the axis of the tracks. The speeds of arriving and departing trains were 30-40 km/hour. The tracks were on the same level with the surface of that area. In a room facing the tracks on the second floor, with double windows and closed ventilation pane, the noise levels were 52-70 db (Table 4) with a low frequency characteristics of the noise (Illustration 3,4).

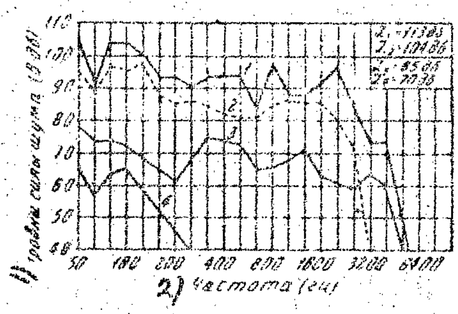

Illustration 3. Spectra of train noise.
1 - external noise of a passenger train at the speed of 135 km/hour; 2 - external noise of passenger train at the speed of 80/hour; 3- external noise from freight trains at the distance of 30-35 m from the tracks at the speed of 30-40 km/hour; 4 - noise spectrum of a freight train in the room at the distance of 32-37 m from the tracks.
Legend: 1) Noise intensity levels (in db); 2) Frequency (in cps).

In the second case the conditions corresponded to a station situated on the transit routes of the trains which ran at the rate of 60-80 km/hour. The main tracks were elevated 1.5-2 m above the surface. It was a one-story house situated 200 m away from the main tracks. The area between the house and the tracks was occupied by vegetable

Table 4

Noise levels in residential buildings depending on the distance from the tracks and the speed of the trains.

1) Место измерения и характеристика точек	2) Скорость (в км/час)	3) Расстояние от оси путей (в м)	4) Уровень шума (в дб)
5) 1. 2-й этаж кирпичного дома			
5a) а) перед окном дома	30—40	30—35	82—87
5b) б) в комнате с двойным остеклением окон, форточка закрыта	30—40	32—37	52—70
6) 2. Одноэтажный деревянный дом			
6a) а) перед окном дома	60—80	200	60—79
6b) б) в комнате с одинарным остеклением:			
6c) форточка закрыта	60—80	202	50—60
6d) форточка открыта	60—80	202	56—62

Legend: 1) Measuring place and description of points; 2) Speed (in km/hour); 3) Distance from the axis of the tracks (in m); 4) Noise level (in db); 5) Two-story brick house; 5a) In front of the window of the house; 5b) In a room with double windows, ventilation pane closed; 6) One-story wooden house; 6a) In front of the window of the house; 6b) In a room with a single frame window; 6c) Ventilation pane closed; 6d) Ventilation vent open.

gardens and sparsely growing trees. The noise levels in the room facing the tracks were: 56-62 db where the ventilation pane was open and 50-60 db when it was closed. Illustration 3 shows the spectra of the outside noise from the passing trains measured with the ASh-2 analyser and the Sh-3 LIOT noise gauge. The obtained noise levels are in excess of 35-40 phons, which are recommended in a number of countries.

The noise from moving trains can be reduced by removing the wavy abrasions from the tracks, installing seamless tracks, placing rubber linings between the foot of the rail and the crosstie. The noise can also be reduced by improving the design and maintenance of the rolling stock.

Conclusions

1. Mechanized marshalling yards and moving trains are intensive sources of noise.

2. In order to reduce the harmful effect of noise on the organism of the yard staff and people residing near the yards, it is necessary to take measures for the reduction and

localization of the noise sources, and not to wait until the yards are moved.

3. It is necessary to increase the health protection zone: from the routes of speedy traffic of trains from 20-50 to 100 m; from mechanized marshalling yards - to 500 m.

4. In order to reduce the noise, it is necessary to outfit all locomotives in the area of cities and settlements with whistles which are not as loud, with the level not over 90 db at a distance of 5 m from the locomotive.

5. At the existing yards, it is necessary to work out measures for reducing the noise; reduce the number and combination of conventional signals by the marshallers, switchmen and engineers (during the shunting operations and moving the cars to a certain route); change the sound signals with optic signals; outfit the points of the locomotive scavenging with mufflers; planting trees and shrubs in the area, etc.

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INVESTIGATION OF THE SOUNDPROOFING PROPERTIES OF PROTECTIVE CONSTRUCTIONS MADE OF VIBRO-ROLLED PANELS

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The author reports the results of the laboratory studies of several types of walls intended for the use between apartments and between rooms, and of several types of floors made of vibro-rolled thin-walled ribbed panels developed in the Institute. The size of the panels is 2800 x 910 mm, thickness - 20 mm, weight of 1 m^2 - about 100 kg. The panels were installed in the apertures of measuring chambers in a vertical position. The seams between the panels and the sides of the aperture were thoroughly filled with a cement solution. The size of the experimental wall was 8 m^2. The following types of walls were studied: a) single, covered on one side along the ribs of the panels with sheets of dry gypsum plastic (the weight of 1 m^2 was 110 kg); b) double, consisting of two walls formed by the panels placed against each other with the ribs inside (the weight of 1 m^2 - 200 kg); c) double, consisting of two walls formed by the panels which were placed with the ribs with a solid layer of soft wood fiber plates 15 mm thick (the weight of 1 m^2 - 204 kg); d) double, of the same structure but padded with two wood fiber plates (the weight of 1 m^2 - 208 kg); d) double, consisting of two walls formed by the panels which were placed with the ribs inside and having an air space of 50 mm in thickness (the weight of 1 m^2 - 200 kg).

The author noted on the basis of his studies that the single construction covered with sheets of dry gypsum plaster may be recommended for soundproofing walls between rooms, because the soundproofing capacity of such construction exceeds the standards for this purpose. Such walls and the double constructions with the panels against each other may also be used, according to the standards, as walls between classrooms in schools, hotel rooms, etc. The double construction with

an air seal and that padded with one layer of wood fiber plates may be recommended for walls between apartments and also for walls in other types of buildings. The use of the double walls padded with two layers of wood fiber plates improves the quality of soundproofing only by 1 db and is not practical for economic reasons.

Two types of floors were studied: a) A divided floor 3.2 x 5.2 m in size, consisting of 2 densely ribbed caisson plates of the floor and the ceiling with partly reinforced ribs 40 cm apart in both directions. The floor plate was 2 cm thick, and the ceiling plate was 1 cm. The reduced thickness of the concrete of the floor was 3.95 cm, of the ceiling - 2.9 cm, and a total of 6.85 cm. The amount of steel used for 1 m^2 of the floor was 5.5 kg. The floor was covered with linoleum over one layer of semirigid wood fiber plates; b) A floor made of vibro-rolled ribbed panels with the ribs up. A floor panel 3.2 x 5.2 m in size was prepared of No. 200 fine-grain concrete. The plate of the supporting panel served as the ceiling, and the cross ribs were the basis of the floor of the upper story. The reduced thickness of the panel was 4.4 cm. The amount of steel used for m^2 of the panel was 3.3 kg. The construction of the protective flooring used in the construction of this floor consists of two layers of boards with one layer of waterproof paper between them. Experiments were also made with a protective flooring consisting of one layer of grooved boards with pergamyn placed under them. It was attached to them with laths. The seams were filled with bitumen. Individual paddings made of soft wood fiber plates and a solid padding of drossy mats in paper were tested as resilient paddings for protective floors.

The author established from the analysis of the obtained data that the floor of the divided type possess a normative soundproofing capacity both from airborne and impact noise (for residential buildings of the Class II); floors made of panels with the ribs up and a wooden flooring possess a normative soundproofing capacity from airborne noise. Soundproofing of the floors from impact noise with the flooring on a solid padding of drossy mats also satisfies the normative requirements for residential buildings of Class I. When the flooring is constructed on individual paddings of soft wood fiber plates, the soundproofing of the floor from impact noise satisfies the normative requirements for residential buildings of the Class II and III.

CONTROLLING NOISE MADE BY PUMPS USED IN DWELLINGS

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The author notes that the noise from pumps in residential buildings is transmitted through the structure of the building, through the base of the pump, through the pipes, and through acoustic "bridges".

Studies have shown that the noise levels in apartments will be the highest (45-50 phons) if the vibrations are transmitted through the pump bases rigidly connected with the floor. When the pipes are rigidly connected to the walls, the noise in the apartments will be somewhat less (40-45 phons). If there are shock absorbers under the bases and flexible inserts in the pipe lines, the noise levels in the apartments will be still higher than the normative value, if the acoustic "bridges" are not eliminated (brackets and props supporting the pipe lines, metal tubes connecting the floor and the base and serving for supplying electricity to the motor, and construction refuse remaining between the base of the pump and the floor). The elimination of the "bridges" may reduce the noise level approximately by 5 phons.

Shock absorbers and insulation of pipe lines should reduce the noise loudness level by not less than 10-15 phons. Thus, when measures were taken to reduce the transmission of noise from the pump room to an apartment in one building, it was found that: prior to these measures, the noise of 60 db used to penetrate into the apartment from the pump room which was situated in the basement (in the pump room it was 74 db); after the pump was placed on a base with a layer of slag wool 4 cm in thickness under it, and when flexible inserts 50-70 cm long were used in the pipe lines, the noise in the apartment reduced to 52 db, and only after the elimination of acoustic "bridges" (placing rubber paddings between the brackets on which rested the pipes and the pipe lines) the level of noise in the apartment dropped to 48 db (37 phons).

The author points out that shock absorbers for the pump bases may be made of resilient materials (rubber or cork) or of steel springs. The latter have a greater range and weaken the vibrations of high and low frequencies, while the former insulate only high-frequency vibration well. The insulation of pipe lines is achieved by using flexible inserts (rubber or canvas) 70-90 cm in length. The spots where the pipes pass through the walls are thoroughly insulated with mineral wool, felt, etc. The pipes (after the inserts are put in) are secured by suspending them from the ceiling or by putting props under them. Paddings, etc., should be used between the pipes and the construction supporting them. It should be noted that very often the walls and the ceiling of the pump room are frequently covered with sound-absorbing materials which results in a reduction of noise only in the pump room, but not in the apartments, and, therefore, such measure is completely impractical.

The opinion that pump rooms which adjoin the building are less noisy is not correct, because the degree of the acoustic condition of the apartment depends exclusively on the quality of vibroinsulation of the protective constructions. A very small exception are the pump rooms situated in deep basements, and detached pump rooms removed from the apartments and not having common protective constructions (walls) with them. Out of the three ways of transmitting vibration, the most probable way of transmission here is the transmission through the pipes.

A METHOD FOR ASSESSING THE NOISE MADE BY COMBUSTION IN PISTON-DRIVEN INTERNAL-COMBUSTION ENGINES

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The author notes that one of the main sources of noise in the internal-combustion engine is the combustion process, while such sources of noise as the intake and exhaust systems can be muffed comparatively easily. Thus, according to the data from the Automobile and Automobile Engine Research Institute, the levels of noise around the MAZ-200 automobile with the YaMZ-236 engine are 100-102 db near the engine, and 90-92 db near the muffler. Particularly high levels of noise (110-120 db) are observed during the testing of automobile engines.

The author points out that since the time constant of most of the objective noise gauges is 0.1-0.15 seconds, which is much greater than the length of the combustion process, it is not possible to use noise gauges for evaluating the noise produced by the combustion process. He suggests in this case to record simultaneously on film the processes occurring in the engine which characterize its work and contain acoustic characteristics. A following acoustic calibration permits to evaluate the instantaneous levels of noise in the course of the working cycle, including the moment of combustion.

Applying this method, he was able to establish that instantaneous maximum levels of noise during combustion are 115-125 db in diesels and 105-115 db in carburetor engines. The noise impulse originates in combustion on the background of the noise caused by the vibration of the engine's parts, and this vibration noise participates in the formation of the noise impulse in combustion. The sensation of the engine noise is formed from the sensation of the vibration noise, on the background of which we hear the intensive high-frequency sound impulses from combustion. The noise impulse from combustion fades gradually. Its length is different in different engines. The greater the momentaneous excess of noise, and the longer the noise impulse, during the moment of

combustian, the more unpleasant is the noise of the working engine.

It is suggested to evaluate the noise from the combustion process by the momentaneous noise level during combustion which is determined from the calibration curve by the maximum amplitude of vibration, momentaneous surpassing of the noise level, and the length of the noise impulse from combustion which is determined by the period of time during which the maximum amplitude of sound vibrations reduces by half. According to the author's materials, diesels have the value of instantaneous surpassing of the noise level of 15-25 db, and the length of the noise impulse from combustion is 8-16 m/sec, while in carburetor engines these indexes are 5-8 db and 5-7 m/sec respectively.

The author considers that in order to reduce combustion noise in internal-combustion engines, and first of all in diesels, it is necessary to reduce the instantaneous maximum noise levels, the instantaneous surpassing of the noise level and the length of the noise impulse from combustion. This values can, in his opinion, be reduced by a number of measures for a retional organization of the working process, by improving the designs of engines and by selecting less "sonorous" materials, which should be decided by research institutes and laboratories of factories in automobile industry.

THE EFFECT OF THE WORK QUALITY ON SOUNDPROOFING

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The author gives a number of examples of the effect of a low quality construction work on the sound-insulating capacity of protective constructions. Thus, in the 5th and 8th buildings of the 9th block in Novyye Cheremushki, because the doors did not close tightly leaving a small opening at the botton and around the frame, the average soundproofing capacity of the walls between rooms was the same (25 db), in spite of the fact that the weight of the wall in the 5th building was 30-35 kg/m^2, and in the 8th building it was 130 kg/m^2. In the house No. 21/4 on Karl Marx Street, the walls between apartments were one-half a brick thick and were covered on both sides with dry plaster with small air gaps, but they were found to have a low sound insulating capacity (lower than the standard requirements) chiefly because of the small air gaps (1-2 cm) and imperfect mortaring of the bricks, as well as an imperfect filling of passages left between sections in the building. The reconstruction of one of the walls bypouring a gypsum solution between the layer of plaster and the wall did not bring the required results, because the gypsum solution did not fill the air gaps completely. Improving its soundproofing at medium frequencies by 5-8 db, it did not change it at low and high frequencies.

In house No. 14 on Novo-Ostankinskaya Street, floors consisting of two rolled reinforced concrete panels with a padding of semirigid wood fiber plates arranged lengthwise along the sides and with a linoleum flooring on mastic laid on a layer of semirigid wood fiber plate was found to have a low soundproofing capacity both from airborne and impact noises. The floors which were studied had rigid contact with the walls. Later, a gap was left between the upper panel of the floor and the wall, which was filled with slag wool or with wood fiber plates. However, it was not possible

to avoid a contact between the upper and the lower panels of the floor. In the corners of the rooms, near the outside wall, during construction the cement solution got between the plates of the floor forming acoustic "bridges". The round holes for the wiring in the middle of the ceiling panel were not thoroughly sealed. In installing the plumbing, metal sleeves were used when the plumbing passed through the floor, which let to a rigid connection in the panels of the floor. The holes in the floor panels were not thoroughly filled. All this made the soundproofing capacity of the floor considerably worse. Such floor can satisfy the standard requirements for airborne and impact noise insulation only if the floor is completely insulated from other supporting constructions.

Thus, in buildings with large panels, the work quality is of great importance for the soundproofing of individual constructions and the entire building. The reason for this is that favorable conditions are created for the transmission of vibrations through protective constructions not only because of their light weight and the fact that they are made of reinforced concrete, but also because the constructions are joined sufficiently rigidly, which is dictated by the considerations of the spatial rigidity of the buildings. Vibrations from the sound energy radiated by the interior parts of the building spread at considerable distance and create much noise in the apartments.

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